November 23, 1959

Aviation Week

Including Space Technology

75 Cents

A McGraw-Hill Publication

First Details On Design Of CL-41 Trainer

Douglas C-133 Airlifts
Convair Atlas ICBM

Rocketdyne Studies Future Liquid Propellants

PRESCRIPTION FOR WEIGHT CONTROL...

Voi-Shan **weight/master hex nuts combine a considerable saving in weight together with a carefully engineered design that meets the needs of a wide range of industry requirements.**

Well-known Voi-Shan **superior quality control and production methods assure a consistent high reliability and effectiveness wherever weight/master is specified.** Excess metal has been **removed without loss of full performance.**

weight/master hex nuts

Now in quantity production in sizes 4-40 through ⅜-24, the **weight/master** hex nut is unequalled as a successful answer to weight control and performance problems. **Weight/master** hex nuts have passed industry-witnessed qualifications tests and may be procured under the following part numbers:

CROSS REFERENCE			WEIGHT/MASTER	
VS PART #	MS #	NAS #	SIZE	LBS/100 PCS
VN 300A40	MS 21042L04	NAS 1291-04	4-40	0355
VN 300A62	MS 21042L06	NAS 1291-06	6-32	0654
VN 300A82	MS 21042L08	NAS 1291-08	8-32	0991
VN 300A02	MS 21042L3	NAS 1291-3	10-32	1440
VN 300A048	MS 21042L4	NAS 1291-4	1/4-28	2340
VN 300A054	MS 21042L5	NAS 1291-5	5/16-24	4180
VN 300A064	MS 21042L6	NAS 1291-6	3/8-24	5500

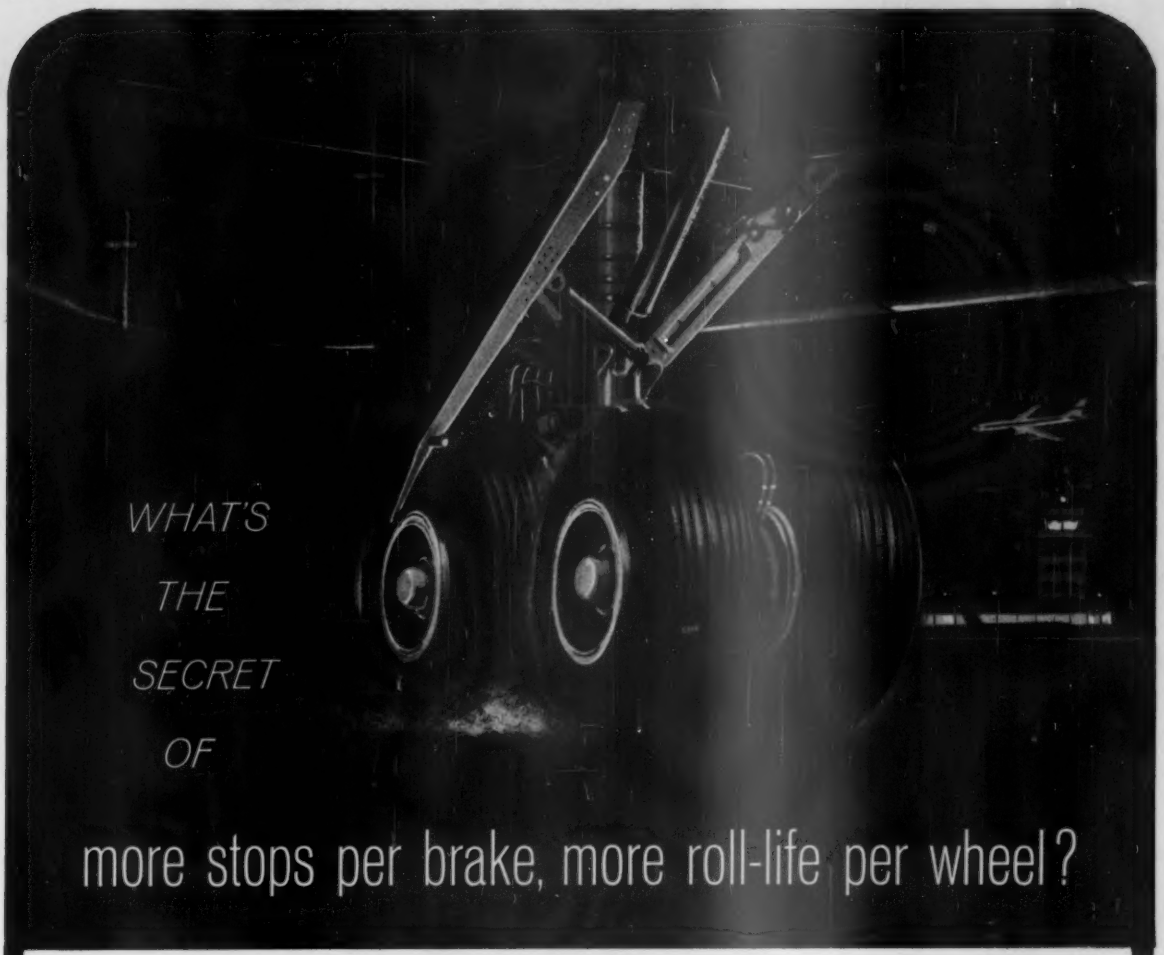
For information on these and other Voi-Shan fastening products write to:

VOI-SHAN

VOI-SHAN MANUFACTURING COMPANY

8463 Higuera Street, Culver City, California

ANOTHER "PLUS" FROM GOODYEAR AVIATION RESEARCH



WHAT'S THE SECRET OF

more stops per brake, more roll-life per wheel?

First, consider this: Goodyear builds more long-roll-life airplane wheels than all other wheel manufacturers combined. It's also a fact that more aircraft, the world over, rely on Goodyear Aviation Brakes than any other kind. Among the new aircraft that depend on Goodyear Wheels and Brakes: Grumman – A2F-1, W2F-1, YAO; North American – T2J; Convair–B-58, 880; Republic–F-105; Lockheed–JETSTAR; Fairchild–F-27.

What's the secret of this overwhelming preference? From Goodyear engineering leadership, dating back to 1909 when Goodyear built the world's first airplane tire, have come wheels of the greatest strength and longest roll-life per pound of metal ever made. It has also produced the famous disc brake, a pioneer Goodyear development which has set the pattern for more efficient braking in a host of fields.

Latest Goodyear advances include the Tri-Metallic Brake and forged aluminum and magnesium wheels—all unmatched for weight-savings and dependability.

Whatever the aircraft—there's a perfect wheel and brake combination for it from Goodyear, ***first choice in its field for 50 years!*** Write for full details. Address Goodyear, Aviation Products Division, Akron 16, Ohio, or Los Angeles 54, California.

AVIATION PRODUCTS BY

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MORE AIRCRAFT LAND ON GOODYEAR TIRES, WHEELS AND BRAKES THAN ON ANY OTHER KIND

59-4

the farther the "reach" the more critical precision becomes

Today's missiles demand tight accuracy because a ten-thousandth of an inch functional error can cause failure to reach the target a continent away. And when you're reaching toward a target almost a quarter of a million miles away, precision becomes even *more* critical!

Ex-Cell-O is in the accuracy business, meeting today's unprecedented demand for precision by building into every part, every assembly, every machine tool an exactness that the aircraft industry has counted on for higher, safer, faster flying for 40 years.

XLO

EX-CELL-O FOR PRECISION

MAN AND MISSILES FLY HIGHER, FASTER AND SAFER WITH PARTS AND ASSEMBLIES BY EX-CELL-O AND ITS SUBSIDIARIES: BRYANT CHUCKING GRINDER CO., CADILLAC GAGE CO., MICHIGAN TOOL CO., SMITH BEARING CO.

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DETROIT 32, MICHIGAN

Aircraft Division

AVIATION CALENDAR

Nov. 30-Dec. 4—Fourth Annual Naval Air Weapons Meet, Operation "Top Gun," Marine Corps Auxiliary Air Station, Yuma, Ariz.

Nov. 30-Dec. 4—First industry and government-wide training course in Value Engineering & Analysis, Industrial Education Institute, Boston, Mass.

Nov. 30-Dec. 4—Annual Meeting, American Society of Mechanical Engineers, Chalfonte and Haddon Hall Hotels, Atlantic City, N. J.

Dec. 1-2—Symposium on the simulated altitude testing of rockets and missile components, USAF's Arnold Engineering Development Center, Arnold Air Force Station, Tenn. (Classified; proper security clearance required.) Sponsors: ARO, Inc.; Space Technology Laboratories, Inc.

Dec. 1-3—Eastern Joint Computer Conference, Statler Hilton Hotel, Boston, Mass. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; Association for Computing Machinery.

Dec. 6-9—52nd Annual Meeting, American Institute of Chemical Engineers, Sheraton-Palace, San Francisco, Calif.

Dec. 7-8—Classified symposium on "The Plasma Sheath, Its Effect on Communication and Detection," Boston, Mass. Sponsor: Electronics Research Directorate, Air Force Cambridge Research Center.

Dec. 7-11—National Conference on the Application of Electrical Insulation, Sheraton-Park Hotel, Washington, D. C. Sponsors: American Institute of Electrical Engineers; National Electrical Manufacturers Assn.

Dec. 8-9—First Aerospace Finishing Symposium, Hotel Texas, Fort Worth, Tex. Sponsors: Society of Aircraft Materials and Process Engineers; Dallas-Fort Worth Branch of the American Electroplaters Society.

(Continued on page 6)

AVIATION WEEK Including Space Technology

November 23, 1959

Vol. 71, No. 21

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The smallest, lightest, PRECISION TRIMMING POT on the market!

FAIRCHILD TYPE 926—3/8" DIAMETER TRIMMER

Smallest?...You can't get one any smaller, not when diameter and length measure only ⅜ of an inch.

Lightest? . . . Although it weighs only 3 grams, this precision micro-miniature trimmer incorporates a machined aluminum case, stainless steel shaft and precious metal wiper and contacts designed for high reliability. It is protected against dust and moisture by an "O" ring shaft seal.

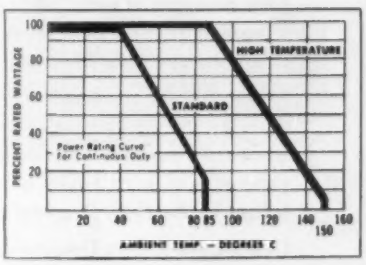
All this and reliability too . . . The Trimtite, Jr. meets MIL SPEC 202A for missile and aircraft applications, assuring constant setting over a wide range of severe environmental conditions.

Standard and high-temperature units are available in resistance ranges as high as 25K with linearity values as low as 3%. Power ratings at various ambients are shown below.

A "GIANT-SIZE" VERSION The Fairchild Trim-tite type 927—measuring ½ inch in diameter and length, and weighing 9 grams —is available in resistance ranges as high as 50K. Resistance values up to 150K can be supplied on special order.

Standard units in a wide range of resistance values are available for off-the-shelf delivery.

For complete specifications and detailed application information regarding your particular requirements, write to Dept. 32Y



RELIABILITY INSIDE THE BLACK BOX

FAIRCHILD CONTROLS CORPORATION

COMPONENTS DIVISION

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PRESSURE TRANSDUCERS
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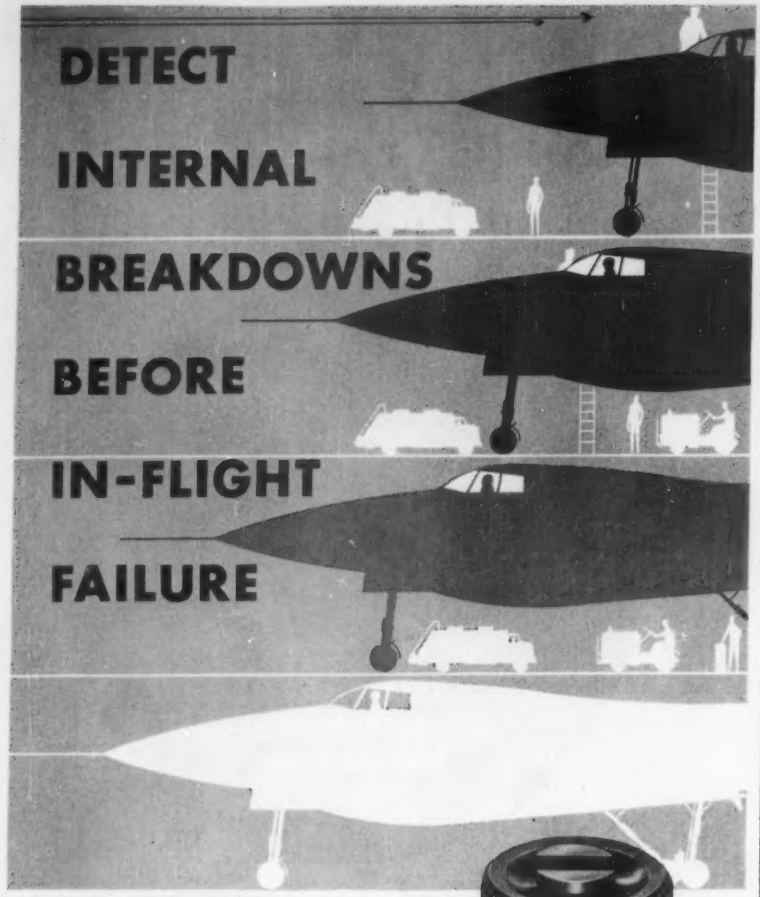
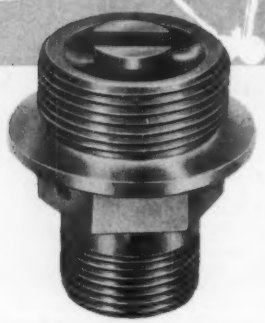
ACCELEROMETERS



LISLE *Magnetic* CHIP DETECTORS



Early detection of metal particles in an engine or accessory lubricant, indicating an impending failure of the unit, can be accomplished with Lisle Magnetic Chip Detectors.

A powerful Alnico magnet in the Chip Detector attracts any ferrous particles that may appear in the lubricant. These particles bridge an electrically insulated gap and complete a circuit which can be ground-checked with a continuity tester—or if permanently wired, activates a light on the Flight Engineer's or Pilot's instrument panel.

Lisle Magnetic Chip Detectors are in service today in engines, accessory drives, propellers, constant speed drives, hydraulic systems, and gear reduction units in most commercial and military aircraft.

LISLE CORPORATION
CLARINDA • IOWA

Write for Catalog and Samples for Testing

AVIATION CALENDAR

(*Continued from page 5*)

Dec. 17—23rd Wright Brothers Lecture, Natural History Bldg., Smithsonian Institution, Washington, D. C. Dr. Alexander H. Flax, chief Air Force scientist, will speak on "High Temperatures in Hypersonic Flow—Physical Principles and Experimental Techniques." Dr. Flax will repeat his lecture on Dec. 18 before the IAS Cleveland Section, on Dec. 21 before the IAS Los Angeles Section, and Dec. 22 before the IAS Texas Section.

Dec. 26-30—Sixth King Orange International Model Plane Meet, Miami, Fla.

Jan. 11-13—Sixth National Symposium on Reliability and Quality Control in Electronics, Statler-Hilton Hotel, Washington, D. C.

Jan. 14-20—Sixth Annual Meeting, American Astronautical Society, Statler-Hilton Hotel, New York, N. Y.

Jan. 25-28—28th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 26.

Jan. 28-29—Solid Propellants Conference, American Rocket Society, Princeton University, Princeton, N. J.

Feb. 3-4—Sixth Annual Midwest Welding Conference, Illinois Tech Chemistry Bldg., Chicago, Ill. Sponsors: Armour Research Foundation of Illinois Institute of Technology; Chicago Section, American Welding Society.

Feb. 3-5—1960 Winter Convention on Military Electronics, Institute of Radio Engineers, Ambassador Hotel, Los Angeles.

Feb. 10-12—Seventh Annual Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.

Mar. 10-11—National Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Cleveland, Ohio.

Apr. 6-8—Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8—1960 National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems, Engineering Societies Bldg., New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Department of Defense Research Agencies; Institute of Radio Engineers.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: National Aeronautics and Space Administration; the Rand Corp.

Apr. 21-22—Southwest Metals & Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

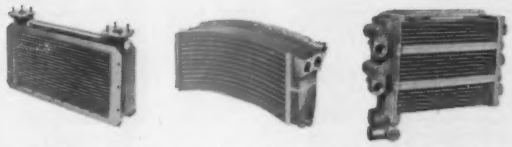
Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

From General Motors . . . Temperatures Made to Order

HIGH-LEVEL TRAVEL DEMANDS SAFE-LEVEL TEMPERATURES

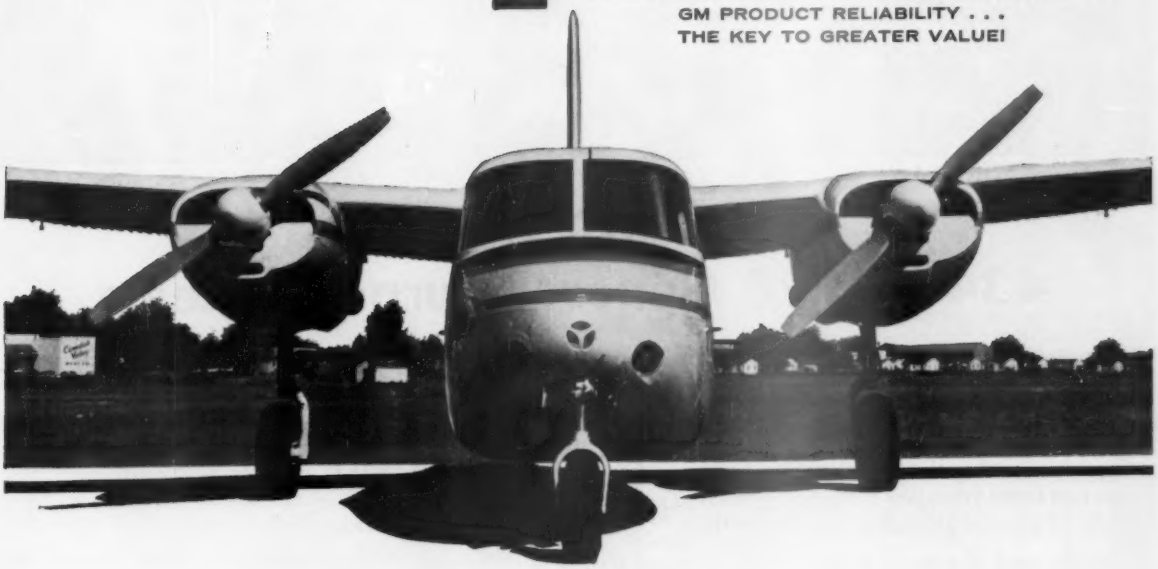
NEW AERO COMMANDER 500 DELIVERS 1100-MILE NON-STOP RANGE . . . HARRISON OIL COOLERS GUARD ENGINE TEMPERATURES

Going up . . . and getting down to business! It's the new Aero Commander 500, the ideal way for the modern businessman to travel. This sleek, ultra-modern executive transport is fleet, maneuverable and comfortable. And Harrison oil coolers get the call to maintain safe, steady engine temperatures. Guarding vital operating temperatures on today's advanced aircraft is a Harrison specialty. It requires the engineering skill, long experience in the heat-transfer field and the research facilities that back every Harrison product. So, if you have a cooling problem, rely on Harrison for the answer.



Harrison Aircraft Oil Coolers—A Quality Product of General Motors Research

GM PRODUCT RELIABILITY . . .
THE KEY TO GREATER VALUE!

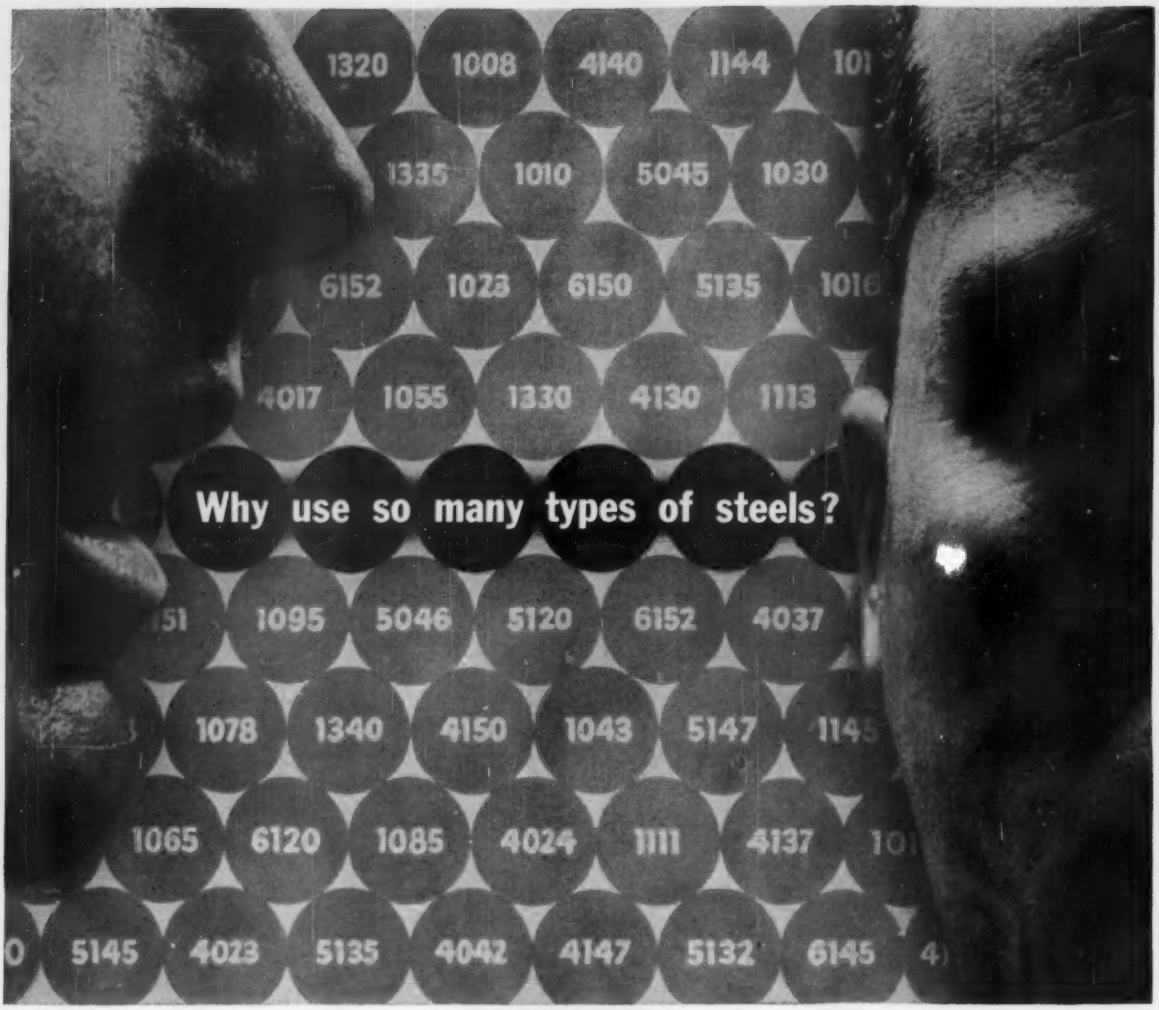


GM HARRISON

TEMPERATURES MADE TO ORDER

AIRCRAFT, AUTOMOTIVE, MARINE AND INDUSTRIAL HEAT EXCHANGERS

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, NEW YORK



Just two will do...
4340, 4620 General Purpose Steels

You make your job easier and you standardize, simplify, and save money...

These two General Purpose alloy steels can solve most of your steel selection problems. One a carburizing type . . . the other a through-hardening type – with just these two alloy steels you can satisfy practically all your engineering requirements.

Here's your chance to standardize on materials. To simplify inventory and processing. To save money in purchasing, inventory, production . . .

When you need through-hardening steel, simply specify 4340. It's ideal for parts of any section size. It provides exceptionally high strength and toughness. Responds reliably to heat treatment. It's weldable under proper conditions and machines at relatively high hardness.

And when you want to carburize, simply specify 4620 steel. It resists warpage and distortion in heat treatment. Responds reliably and uniformly, too. Provides a tough, strong core to support the hard wear-resistant case.

Best of all, both are carried by Steel Service Centers from coast to coast, ready for delivery right off the shelf. If you need heavier-duty or special purpose steels for very particular applications, suitable nickel alloy steels are also available from your Steel Service Center. To get a buyer's guide of centers that carry 4340, 4620, and other nickel-containing grades, simply write Inco.

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INCO TRADE MARK

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67 Wall Street
New York 5, N. Y.

No throttling losses

On the Hound Dog missile, this Sundstrand variable displacement, constant speed motor drives a flange-mounted generator to provide constant frequency a-c power from the main hydraulic bus. Output speed is controlled to ±1%.

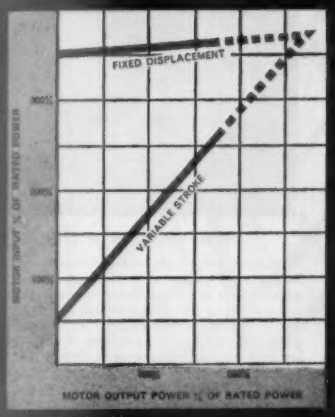
with Sundstrand variable displacement hydraulic motors

Freedom from throttling losses makes the variable displacement type very attractive for a variety of aircraft and missile applications.

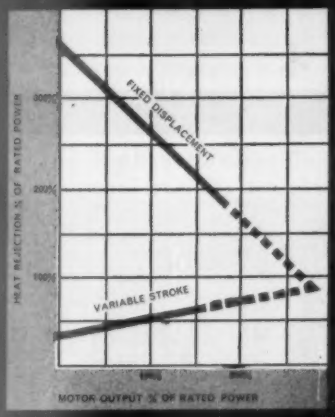
As shown in the graphs at the right, the losses involved in normal operation of a fixed displacement motor are considerably greater than is sometimes expected from a casual estimate.

Sundstrand Aviation is experienced in the development of both types of motors to meet the specific requirements of constant or variable speed applications.

A new booklet discussing Sundstrand "controlled speed" motors is available upon request to the addresses below.



Comparison charts of fundamental losses 3000 psi fixed and variable displacement motors specified for 100% overload, close transient speed control (requiring acceleration torque), and 2500 psi minimum pressure differential.



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AIR MOUNTED RECON
FOR THE NEW U.S. ARMY

and there's a BELL in the Picture

If nuclear war comes, Army Aviation will have a role all its own. It has been given a number of short range, low-level assignments that will augment all activities of ground forces. In such an event, observation will become a more exacting job than ever before; no longer will there be large concentrations of forces and well defined battle areas. Bell helicopters, with their jack-in-the-box agility, will help the new Army maintain such observation over the constantly changing battlefield. They will gather and transmit information for locating, verifying and evaluating targets for artillery and guided missiles; for adjusting fire. They will seek out enemy forces and provide commanders with close-up reconnaissance of atomic blast areas. These are, of course, jobs of the most vital importance. The abilities of the Bell, as of all Army aircraft, may hold the key not only to the new Army's mobility, but to victory on atomic battlefields.

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is informing our nation on the progress of today's NEW U. S. Army and its accelerated program of modernization to keep pace with the changes in the means and methods of modern warfare.

**One of a series of ads currently appearing in such opinion-making publications as Fortune, Business Week and U. S. News & World Report.*

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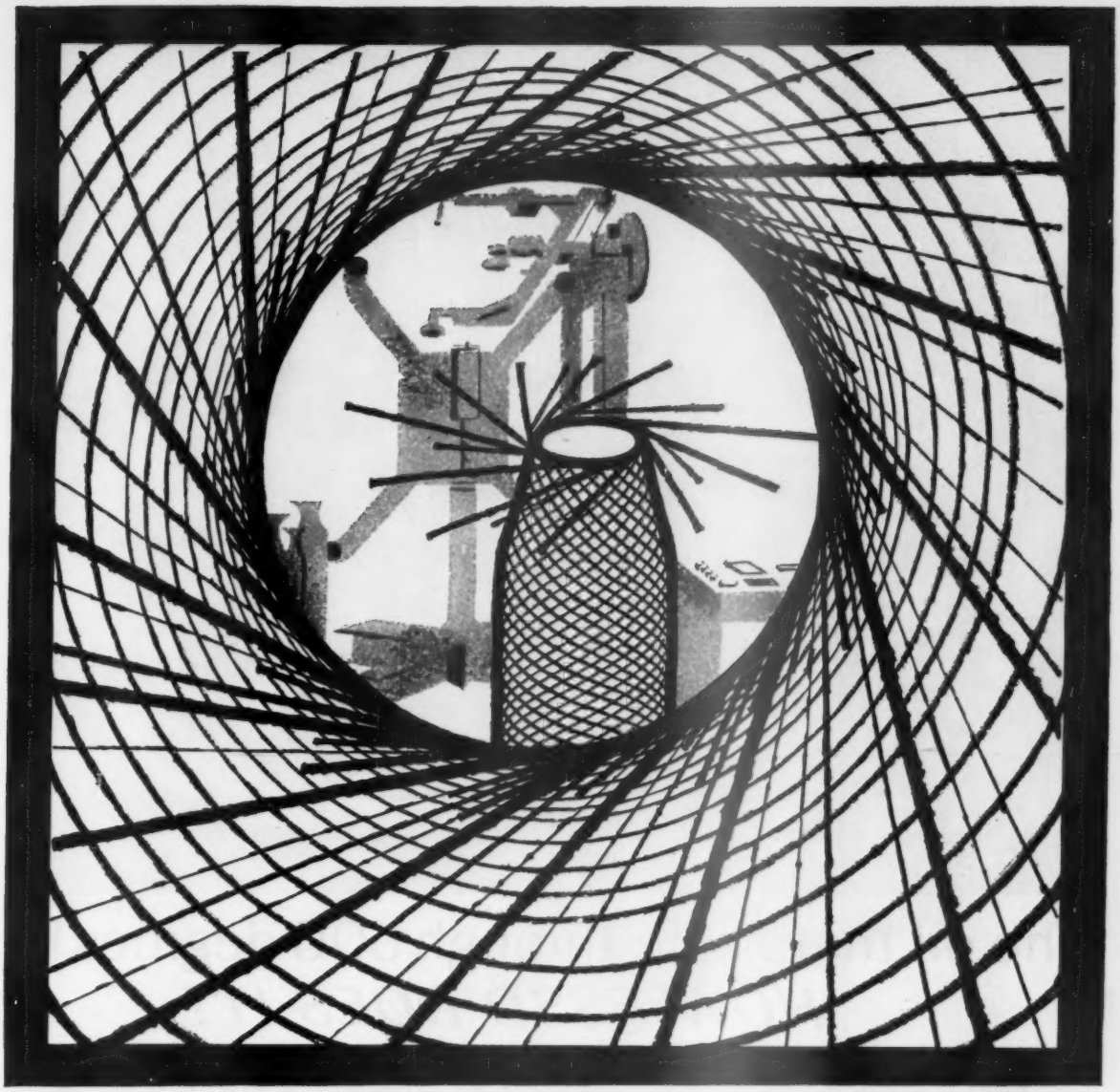


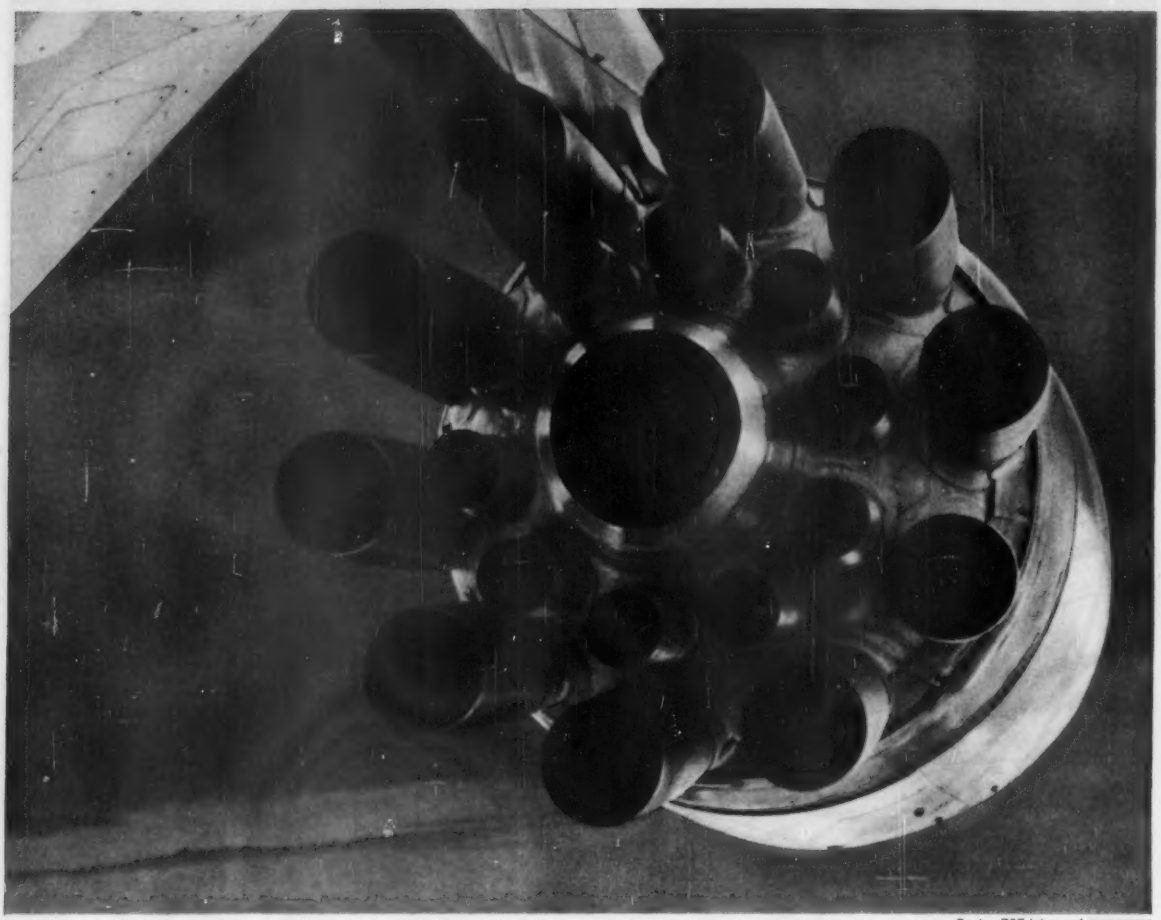
BRUNSWICK WINDS S-D RATIOS UP TO 2,000,000!

You can get an idea of the remarkable power of Brunswick's exclusive Strickland "B" Process (SBP) from the fact that it winds fiberglass filament to a strength-density ratio of 2,000,000. (The SD ratio of high strength steels is 800,000.) The hoop tensile values of these products have averaged 200,000 psi, and their composite wall strengths range from 120,000 to 140,000 psi. SBP gives unmatched reliability and precision in the winding of structural elements, bodies, internally and externally loaded vessels and large cylinders. The process provides unusually close machine resin impregnation control, and variable control of glass density. The winding equipment shown above will produce units up to 12 feet long and 6 feet in diameter. With slight modifications, it will wind much larger units.

Get more information on how SBP can serve you. Write or call: The Brunswick-Balke-Collender Company, Defense Products Division Sales Manager, 1700 Messler Street, Muskegon, Michigan—today!

BRUNSWICK

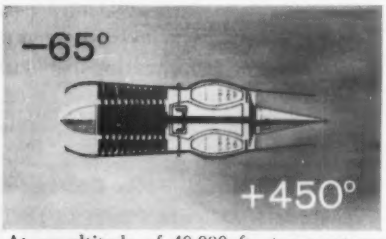
MAKES YOUR IDEAS *WORK*



Boeing 707 jet sound suppressor

The oil that's safe through 500 degrees F:
HOW ESSO DOES IT!

Jet age aircraft make unprecedented demands on lubricants. Not even the most highly refined mineral oils are able to cope with the temperature extremes in turbine engines. Needed was a *synthetic* oil with good lubricity and stability at very *high* temperatures—and easy-flowing properties at very *low* temperatures. Esso was the first successfully to develop such an oil.

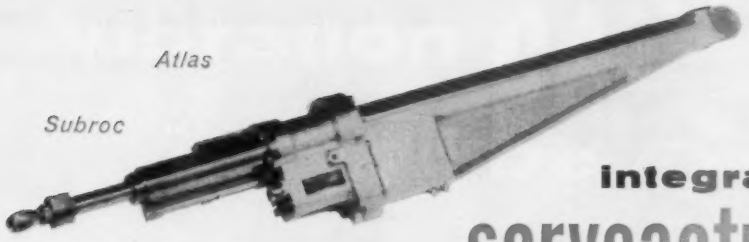


At an altitude of 40,000 ft., temperatures near the intake can be as low as −65° F. Yet in some of the highly-loaded bearings, with rpm up to 14,000, they may soar to 450° F.

Esso synthetic engine oils were ready *before* the first turboprop Viscounts entered commercial service. Esso Aviation Turbo Oils 35 and 15 were the first approved oils for *all* turbine-powered airliners. In fact, the development of these engines depended upon the availability of Esso Aviation Turbo Oils!

INTERNATIONAL AVIATION PETROLEUM SERVICE

ESSO



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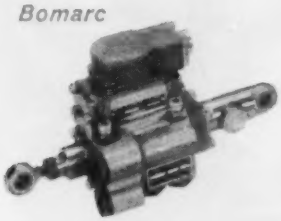
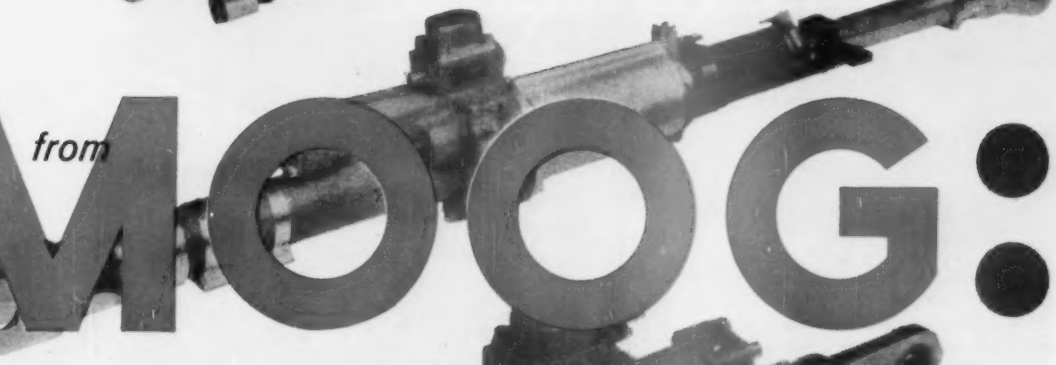


Titan

integrated servoactuator units

...are providing compact, lightweight, reliable actuation for critical flight control systems.

from MOOG:



Jupiter

F-102

Goose

Saturn

MOOG servoactuator packages are custom-designed for each application. These packages usually include an electrohydraulic servovalve, a cylinder-piston assembly and an electrical or mechanical feedback transducer. Various auxiliary control devices are often included within the actuator to reduce weight and improve overall reliability.

MOOG can apply this package know-how to the solution of your actuation requirements.

Write for catalog 170.

MOOG SERVOCONTROLS, INC. PRONER AIRPORT, EAST AURORA, N. Y.

LEADING INNOVATOR AND PRODUCER OF ADVANCED ELECTROHYDRAULIC SERVOVALVES

SINGLE GAS TURBINE UNIT *provides fast starts, electrical power, cooling and heating*

Truck installation with AiResearch Gas Turbine Compressor Unit (GTCP 85-91) supplies pneumatic power for main engine starting, cooling and heating, and electrical power.

Eastern Air Lines selects AiResearch

• Eastern Air Lines, long a leader in technological advances in the industry, has selected the AiResearch multi-purpose gas turbine power unit for starting of main engines, electrical power, and ground cooling and heating of its new Electra fleet. Eastern was the first airline to place an order for this equipment and in recognizing the advantages of combining these functions in one unit.

With over 50 mobile trucks now operating in 32 cities covering 20 states, Puerto Rico and Canada, approximately 3,000 scheduled departure engine starts were, for example, completed in May of this year. This included more than 2,200 hours of turbine operation, also used to supply electrical power and maintenance engine starts.

Heart of the lightweight ground support systems are AiResearch gas turbine compressor power units capable of delivering both electrical and pneumatic power. Quick starting by pushbutton without warmup, they operate in any weather extreme from −65°F. to +130°F.

AiResearch's versatile ground support equipment is tailored to meet the requirements of the rapidly expanding commercial airline fleets of new turbine-powered airliners, military aircraft and tactical missiles. Lightweight, compact units can be designed to specific configurations or installed on standard vehicles.

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

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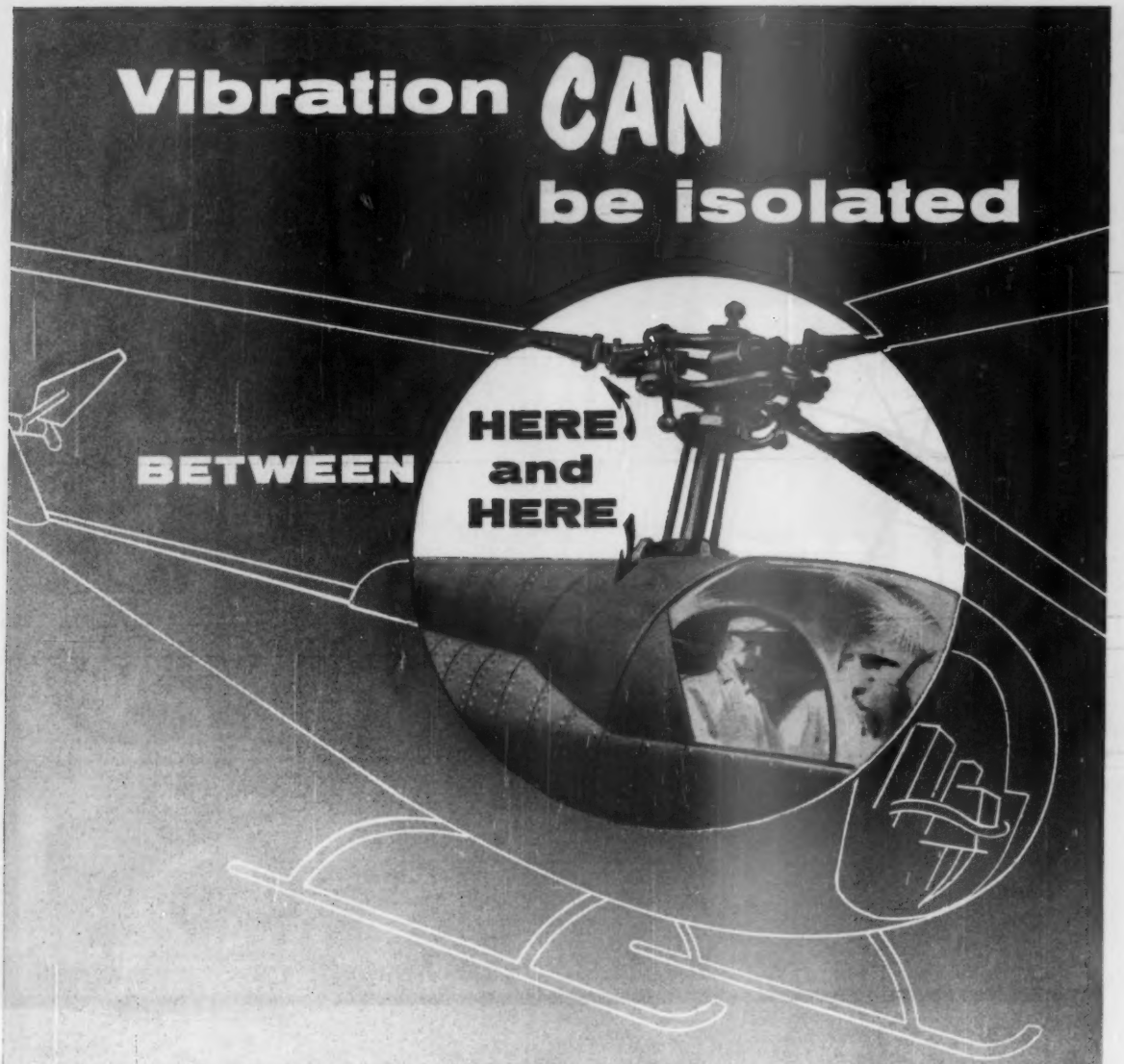

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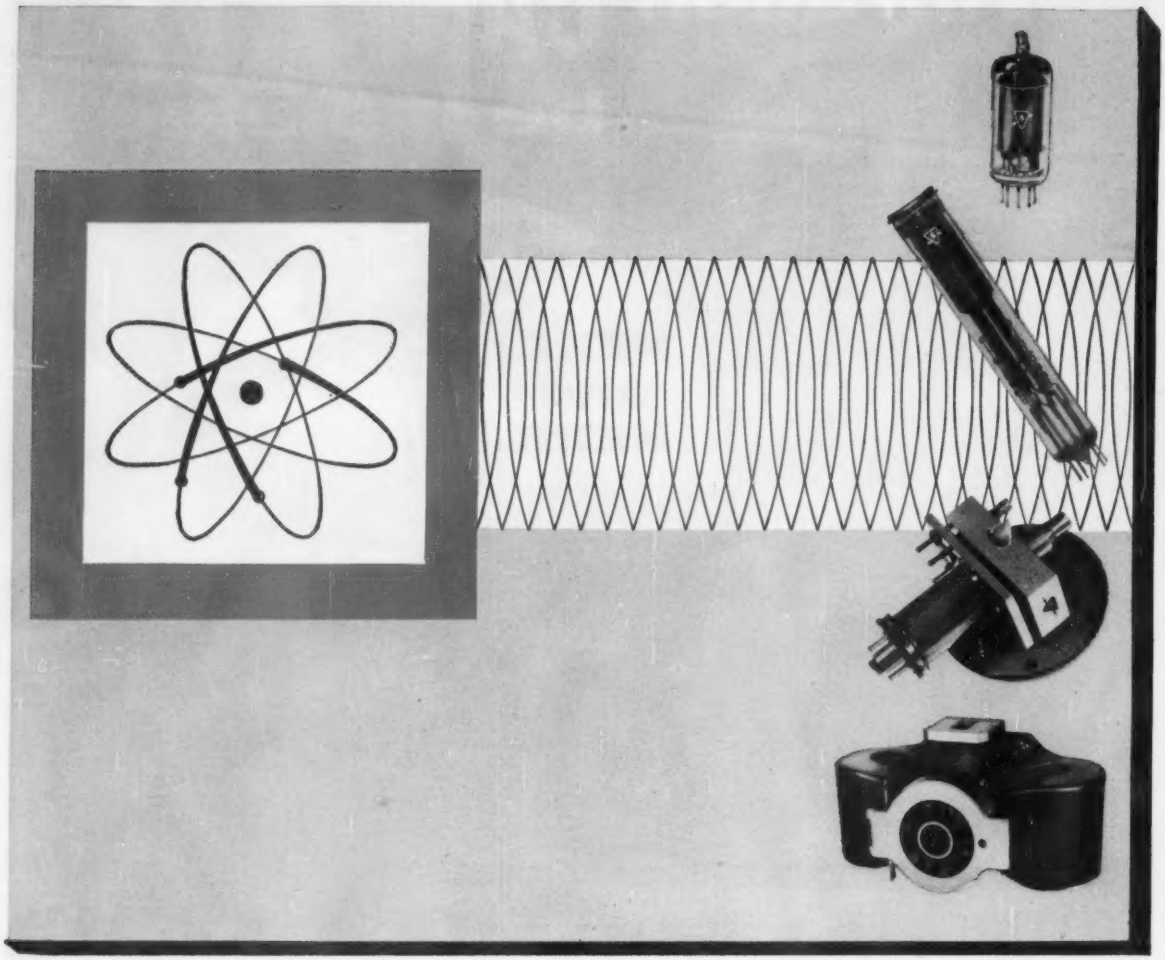

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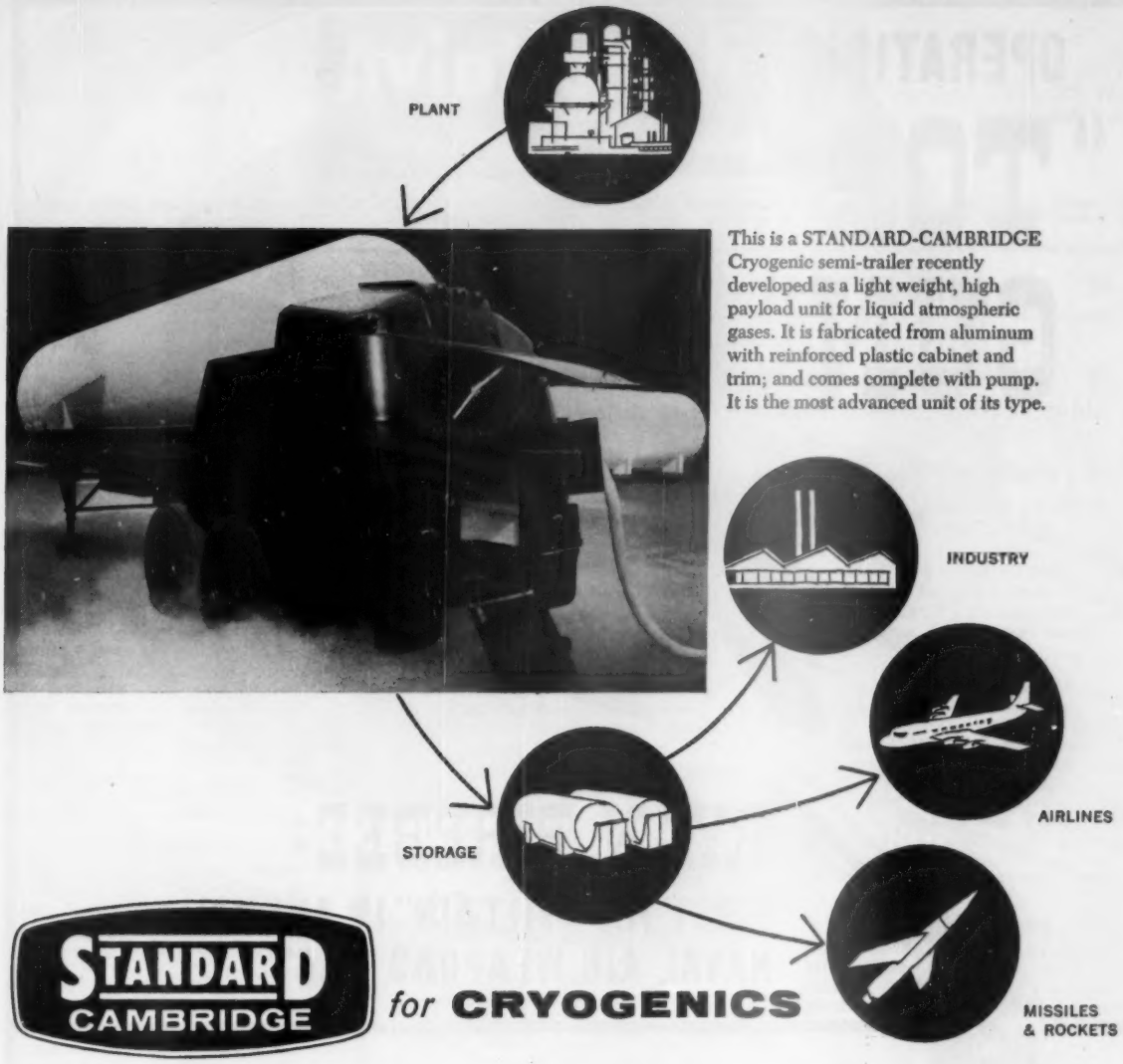

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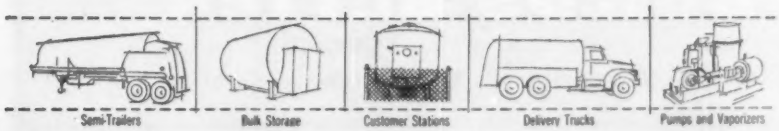
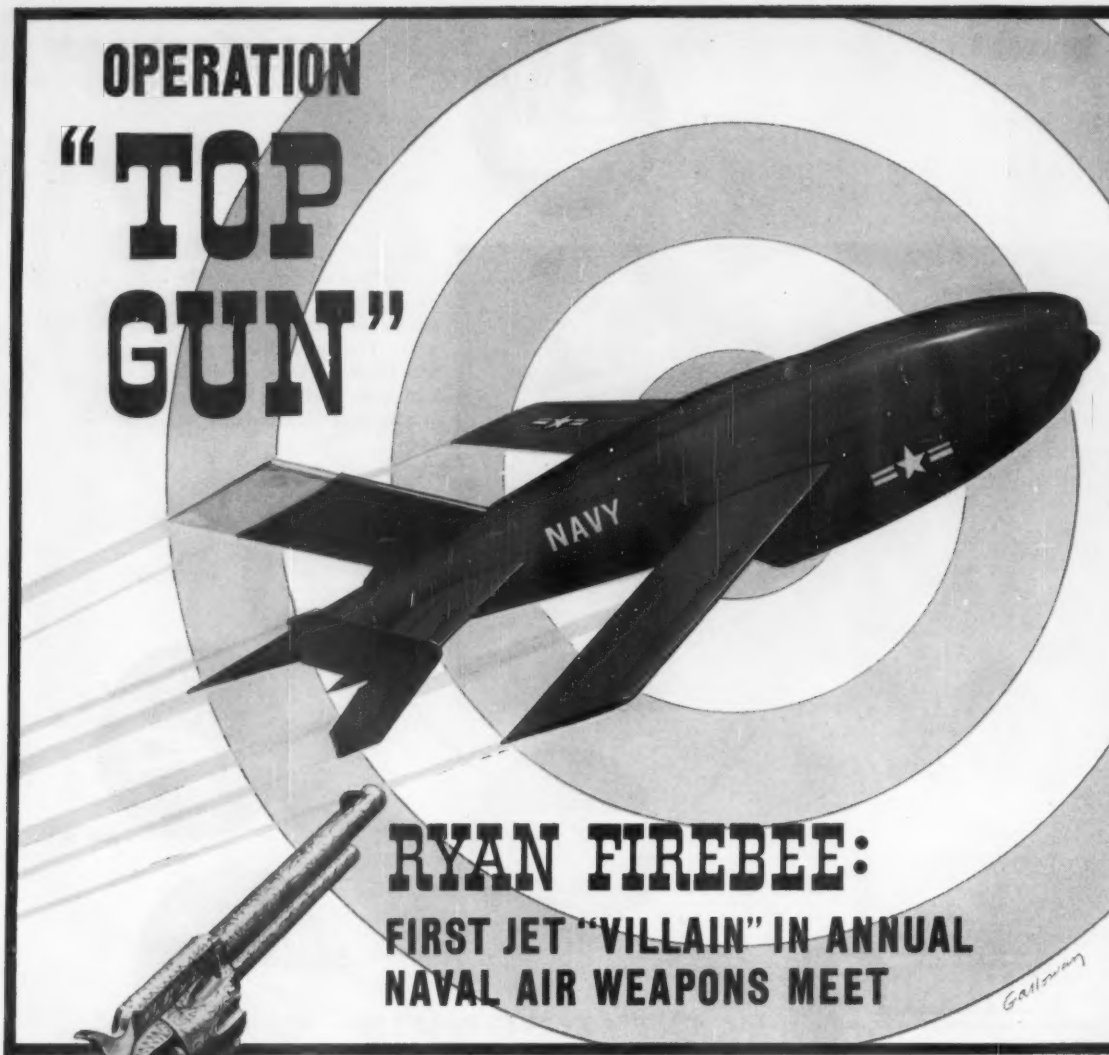


OPERATION "TOP GUN"



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U. S. Space Officials Rap Lack of Urgency..... 26
▶ White House attitude on military participation, need to compete cited by Pickering, Gen. Boushey.

Study Predicts Mach 2-3 Transport Costs..... 36
▶ ARDC-sponsored project concludes fuel will be major item; greater productivity is cited.

Rocketdyne Studies Pumps, Future Liquid Propellants 56
▶ North American Division evaluates gas-driven turbopumps, thrust vectoring devices as rocketry research gains momentum.

SPACE TECHNOLOGY
Space Officials Rap Lack of Urgency.. 26
Soviets View Man-in-Space..... 27
Re-Entry Blackouts Probed..... 28
NATO Research Project Proposed... 30
Plastic Heat Shield for Mercury.... 31
Solids Make Bid for Booster Role... 32
Nuclear Auxiliary Space System..... 35
McDonnell Polysonic Wind Tunnel.. 74

AERONAUTICAL ENGINEERING
Turbojet CL-41 Design Details..... 79
F-104s Leave ADC..... 30
Lockheed 'Bush Plane'..... 33

MISSILE ENGINEERING
Rocketdyne Studies Propellants..... 56
Second Titan B Try..... 31
German Rescue Rocket..... 69

AVIONICS
FAA Expands Radar Network..... 103
Airborne Digital Timer..... 113
Filter Center 110

EQUIPMENT
Rocket Heat Converted to Power.... 92
Production Briefing 101
New Aviation Products 125
What's New 129

SAFETY
Turbulence Blamed in Breakup..... 131

AIR TRANSPORT
Mach 2.5-3 Transport Study..... 36
American Shuffles Management..... 39
City Opposes Third Hawaii Carrier.. 39
IATA Manufacturers' Ban..... 41
Braniff Sets 707 Service..... 41
Soviets Rap French Aviation..... 41
Convair 880 Production..... 43
Swissair DC-8, Caravelle Runs..... 43
F-27 Effect on West Coast Subsidy... 43
New Local Service Plan Urged..... 45
Mail Program Stalled..... 46
Credit Card System Disputed 52
American Shippers Lose Rights..... 52
Shortlines 47
Airline Observer 47
Airline Income & Expenses..... 50

MANAGEMENT
Boeing-Vertol Merger 29
Who's Where 23
Industry Observer 23
Washington Roundup 25
News Digest 35

BUSINESS FLYING
Aerocar Pilot Report 116
Cessna 150 'Patroller' Door..... 117
Second Prototype Porter..... 119
Business Aircraft Shipments 123

Calendar 5
Letters 150

EDITORIAL
Do We Have a Space Program?..... 21

COVER: First airlift of an Atlas ICBM is made with a modified Douglas C-133. Aft loading of the 75-ft. missile is made possible by installation of clamshell doors that open in four directions. The missile is being loaded at Miramar Air Station, San Diego, Calif., for airlift to USAF's Ballistic Missile Division, Francis E. Warren AFB, Wyo. Purpose of the flight is to evaluate capability of airlifting Atlas; all previous movements of this intercontinental ballistic missile have been made with truck-trailers. Second Atlas was airlifted Nov. 9.

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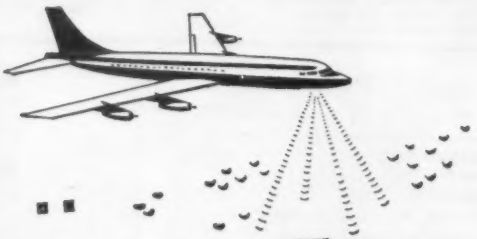

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EDITORIAL

Do We Have a Space Program?

The question "Do We Have a Space Program?" was raised at the American Rocket Society meeting in Washington last week by Dr. William Pickering, director of Cal-Tech's Jet Propulsion Laboratory (see p. 26). This question has been raised before in Congress and by the press, but Dr. Pickering's forthright speech is the first time a major participant in the space program and a responsible man with long practical experience in the new technologies on which space research depends has raised this issue in a public forum.

Perhaps only coincidentally, one of Dr. Pickering's JPL colleagues, Dr. Eberhardt Rechtin, head of the JPL guidance laboratory, also delivered an even blunter blast at the scope and pace of our current space program in a Los Angeles speech. Again at the Rocket Society meeting, a sharp challenge to the prevailing official Administration view denigrating the possible military value of space research was offered by Brig. Gen. Homer Boushey, one of USAF's most experienced research and development experts and an early proponent of a military space program.

These speeches, coupled with more intemperate outbursts by less qualified people, are symptomatic, we think, of a rising groundswell of impatience with top-level official indifference to the national space program. This official attitude, expressed many times by President Eisenhower and his White House advisers, that space research is a leisurely scientific program to be pursued within stringent budgetary limitations without any regard to the Soviet progress in this field and without any hope of any eventual military applications is clearly not in tune with the opinions of most scientists now working on space technology, the temper of the American people or the realities of the international situation.

Dr. Pickering bluntly emphasizes that the race in space research is a focal point in the fierce competition between the political philosophies of this country and the Soviet Union whether we choose to acknowledge this fact or not.

"The Cold War . . . is fought for the control of minds of men. The target is the domination of the emotions and intelligence of men everywhere, and instead of being conducted by tanks, aircraft and naval vessels, it is fought in financial markets, in newspapers, on radio and television programs and by word of mouth. Drawn up in this conflict are two political philosophies both strong, both competitive and both resourceful.

"One philosophy says simply that the mind of man functions most nobly and achieves its greatest expression when it is free. The other says that the mind of man is subordinate to the will of the state. It is the United States against Russia, and its most important campaign is being fought far out in the empty reaches of space."

Dr. Pickering also emphasizes, as we have many times, that the most important ingredient missing from our current space program is the lack of a firmly stated and positively executed top-level determination to equal or exceed the achievements of the Russians in space. And the most important reason we need this missing ingredient, Dr. Pickering says, is above and beyond the scientific, military or economic benefits that may accrue from such a space research program. It is to preserve and maintain our national stature and prestige in the world, according to Dr. Pickering.

"This is not by any means solely for reasons of nationalistic pride," he said, "but rather for very hard headed economic reasons. For much of the twentieth century, the world has looked at the United States as being the leader in technology and engineering. At this time, too much of the world is now asking 'is it Russia or is it the United States which is the technological leader?'

"As a consequence, many decisions affecting our economic welfare are being made against a background of USSR achievement and development in this area. As far as the rest of the world is concerned, it is also perfectly clear that we are in a space race with Russia. . . . It is also perfectly clear that in the post-Sputnik era we have not within these two years succeeded in matching Russian achievements.

"We must either pursue our space developments actively and successfully or we must declare ourselves completely out of the space race."

Dr. Pickering proposed the following action now aimed at establishing our proper position in space technology:

- **"We must establish our long-terms goals as a nation** in our own space exploration program and then quit jumping every time the Russians fly another space experiment.
- **"We must establish goals that are susceptible of engineering achievement** and which will provide significant and dramatic progress in space.
- **"We must clarify management responsibilities and priorities** in our space program. We do not necessarily need to have a single space program, but we must clearly understand in what areas we can afford the luxury of parallel approaches and peripheral projects.
- **"As individuals, as professional engineers and scientists** it appears to me our task is to educate the public and Congress to the realities and needs of a national space program—not only the realities of space but also the realities of time and money required to accomplish results.
- **"We must, with patience and understanding, encourage and support** those who are actively working on the program. Success will come only as a logical consequence of public understanding, public support and hard engineering achievement."

Dr. Pickering's refreshingly realistic approach to the admittedly unpalatable facts of our current national space program are both welcome and badly needed as an antidote to the official gruel being dispensed on the subject these days. Perhaps it may occur to many that a man with Dr. Pickering's technical experience and realistic vigor might make a more inspired leader of our national space program than some of the scientists who have been brought to the White House and its ancilliaries in the post-Sputnik era. The Administration apparently has been more concerned with using these scientists to lend technical respectability to its current ultra-conservative policies rather than to provide the aggressive technical leadership this country needs so badly at this particular time.

—Robert Hotz

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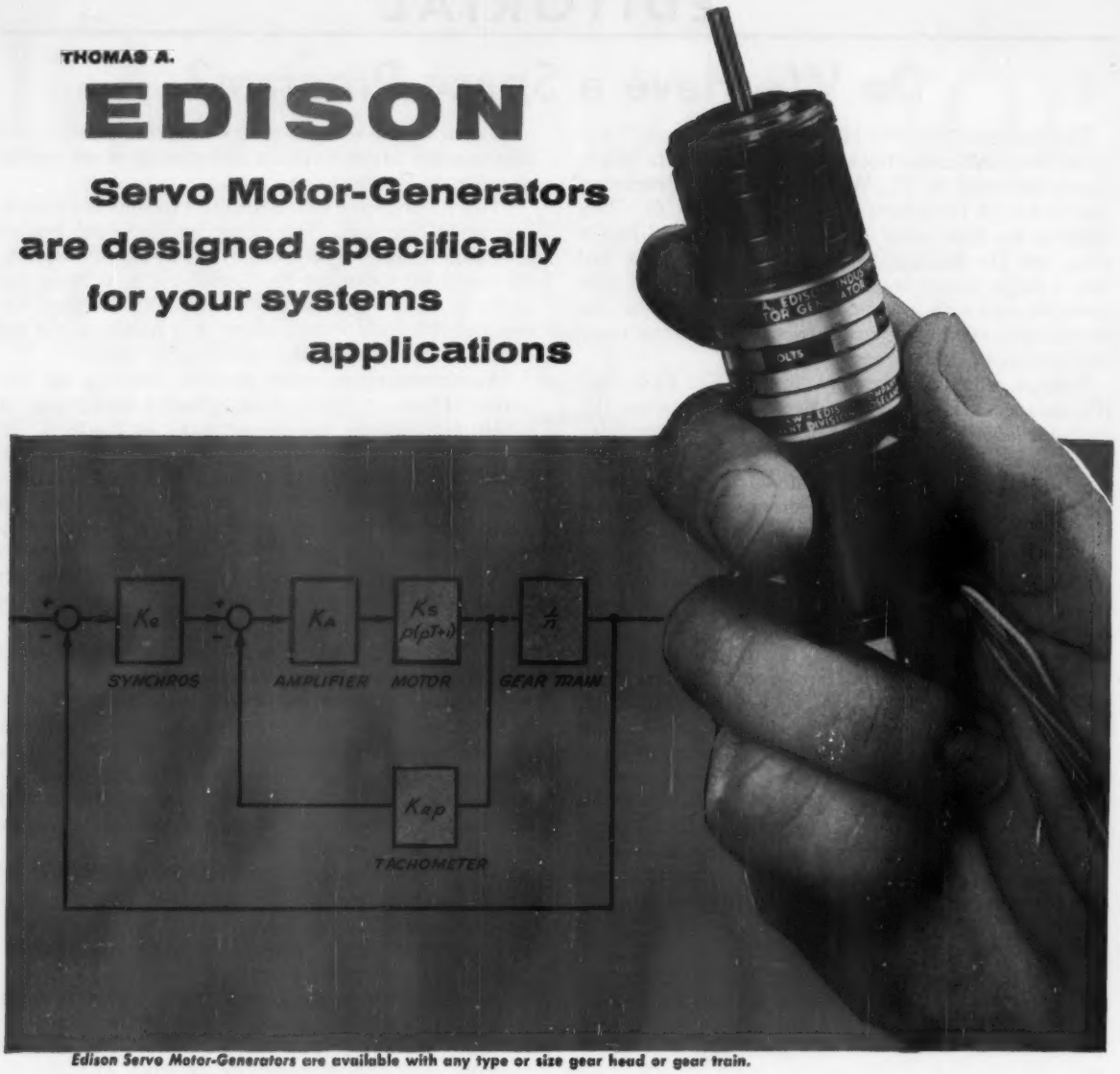

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Walter H. Venghaus, vice president and manager of manufacturing, Narda Ultrasonics Corp., Westbury, N. Y.

Richard A. Campbell, vice president-operations, Pacific Semiconductors, Inc., Culver City, Calif., a subsidiary of Thompson Ramo Wooldridge, Inc. Mr. Campbell succeeds **Warren B. Hayes** who has joined TRW as the president's assistant for new enterprises.

David E. Shonerd, vice president-engineering, Rocket Power, Inc., Mesa, Ariz., a division of The Gabriel Co.

J. R. Johnson, executive vice president, Royal Industries, Inc., Alhambra, Calif.

Hugh C. Bream, vice president, Western Design Division of U. S. Industries, Inc., Santa Barbara and Montebello, Calif. Also: **Ben J. Newitt,** executive assistant to the division president.

W. R. Clay, a division vice president and engineering department manager, Radioplane, a division of Northrop Corp., Van Nuys, Calif.

Honors and Elections

Frederick F. Robinson, a director, Collins Radio Co., Cedar Rapids, Iowa. Mr. Robinson is president and director of National Aviation Corp.

George S. Moore, a director, United Aircraft Corp., East Hartford, Conn. Mr. Moore is president of the First National City Bank of New York.

Peter H. Stanton, board chairman and chief executive officer of American Avionics, Inc., Los Angeles, Calif.

Col. Arthur F. Merewether (USAF, ret.), manager-weather services for American Airlines, has been elected chairman of the Meteorological Committee of the Air Transport Assn. of America, Washington, D. C.

Prof. Thomas Gold, director, and **Prof. Henry G. Booker,** associate director, of the newly established Cornell University Center for Radiophysics and Space Research, which is to have the world's largest and most powerful radar at its disposal. Prof. Gold is professor of astronomy, a professor of electrical engineering and a professor of physics at Cornell; Prof. Booker is director of the School of Electrical Engineering, professor of engineering physics and professor of physics.

R. C. Chilton, vice president-development planning of Horkey-Moore Associates, has been elected a member of the Society of Experimental Test Pilots, Lancaster, Calif. For 10 years (1941-51) Mr. Chilton was senior engineering test pilot for North American Aviation, Inc., during which time he conducted the first and subsequent developmental flights of experimental and production aircraft for Army and Navy.

(*Continued on p. 140*)

INDUSTRY OBSERVER

► Watch for the Convair F-106 to make an official attempt to take the absolute world speed record back from the Soviet Union. F-106 flown by USAF pilots at Edwards AFB, Calif., already has hit 1,530 mph. in level flight, more than the required 3% above the 1,484 mph. record recently set by the Soviet Sukhoi delta (AW Nov. 9, p. 30). F-106 also will go after the official 100 km. record now held by the Dassault Mirage III-A and a transcontinental U. S. speed record.

► **Free flight model of the Dyna-Soar has been fired at Holloman AFB, N. M., by Boeing Airplane Co. using a Curtiss-Wright hypersonic test vehicle to boost the model to 30,000-40,000 ft. High speed exit through the earth's atmosphere simulates re-entry conditions. Second free flight shot is scheduled for December from Holloman.**

► Air Force still has not decided on the magnitude of the Dyna-Soar program. It has asked contractors to prepare proposals that would range from a rock bottom cost of $40 to $50 million for the first year all the way up to $150 million, which is higher than the figure used in the original proposals before Boeing and Martin were chosen to build the vehicle and boosters respectively (AW Nov. 16, p. 26).

► **Watch for Howard Hughes to attempt to shave 30 min. from the jet transport transcontinental speed record with a Convair 880 powered by the General Electric CJ805 turbojet. Hughes has padlocked an 880 aircraft scheduled for delivery to Trans World Airlines and has refused to allow Convair to finish the aircraft interior. Record attempt probably will be timed as part of the promotional fanfare introducing the 880 on TWA regularly scheduled service.**

► Attempt to fire a payload toward the orbit of Venus using a Thor Able vehicle is now scheduled for Dec. 10, exactly two weeks after the scheduled date for an attempt to send a television scanning payload into an orbit around the moon using an Atlas Able vehicle. Both of these shots are being conducted by the Air Force's Ballistic Missile Division and Space Technology Laboratories, Inc., for the National Aeronautics and Space Administration.

► **Tactical Air Command will test Curtiss-Wright's Skydart I solid rocket aerial target this week from Nellis AFB, Nev., using Sidewinders and other air-to-air missiles in an effort to knock the target down. Skydart has 90 sec. of powered flight, will fly Mach .3 to .4 faster than the launching aircraft.**

► Unstabilized nose cone carrying a camera and color films will be fired aboard a USAF Thor from Cape Canaveral, Fla., about Dec. 1. Cone is made and will be instrumented by General Electric's Missile and Space Vehicle Department. General Electric also has asked permission to fire a stabilized Thor and two stabilized Atlas cones carrying color cameras. The unstabilized Thor payload, only shot approved thus far, will carry the color camera as the primary experiment.

► **Convair B-58 that recently broke up in flight killing its company test crew was conducting yaw tests at high Mach numbers with a pod. B-58 was flying past Mach 2 when an outboard engine was deliberately cut to measure resultant yaw effects. Aircraft broke up during this maneuver. As a result of the accident, Convair has voluntarily decided to hold the B-58 to a speed range of just above Mach 1 until the accident investigation is completed.**

► Poland has built a 20-passenger four-engine MD-12 transport which is now undergoing flight tests. Aircraft reportedly has a cruising speed of 177 mph. and a maximum range of 279 mi. It is designed to operate from runways only 1,476 ft. long. Powered by 340-hp. piston engines, the craft is 51.8 ft. long, has a wing span of 69.9 ft. and a wing area of 592 sq. ft. Useful load is 3,850 lb., flying weight is 16,500 lb.

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Other single crystals, such as ruby and doped titania for maser amplifiers are available. LINDE also supplies single crystal yttrium iron garnet, for solid-state devices.

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Washington Roundup

USAF Space Management Review

Extensive review of the structure of Air Force ballistic missile and space management programs is being conducted by a special committee appointed by USAF Secretary James Douglas and headed by Dr. Clark Millikin, president of the California Institute of Technology. Purpose of the organizational study is to obtain recommendations for the "best possible management structures" to direct Air Force missile and space programs. A report is scheduled to be submitted to Douglas by the end of the year.

Other members of the committee are Dr. Hendrik W. Bode, Bell Telephone Laboratories; Malcolm P. Ferguson, president of Bendix Aviation Corp.; Robert L. Hamill, president of Hamill Corp., a director of Pan American World Airways and partner of Sanderson & Porter Co.; Dr. Lawrence A. Hyland, vice president and general manager of Hughes Aircraft Co.; Roger Lewis, vice president of Pan American World Airways; Charles A. Lindbergh; Maj. Gen. James McCormack (USAF-ret.) vice president of Massachusetts Institute of Technology and former vice commander of the Air Research and Development Command; Dr. Emanuel Piore, Massachusetts Institute of Technology physicist, and Dr. Jerome B. Wiesner, director of Raytheon Manufacturing Co. and a professor at the Massachusetts Institute of Technology.

Hebert Reports

Staff of House Armed Services Investigating Subcommittee headed by Rep. Edward Hebert (D.-La.), has completed two reports—one on weapon system contracting, the other on contractor influence on Defense Department procurement. The subcommittee held comprehensive hearings on weapon system procurement in the spring (AW Apr. 27, p. 31) and on "munitions lobby" charges in the fall (AW Aug. 24, p. 33). Because of the difficulty in convening the full Armed Services Committee to pass on the reports during the congressional recess, the reports probably will not be made public until after Congress convenes in January.

Meanwhile, the Defense Accounting and Auditing Division of General Accounting Office has completed a report on Air Force administration of its ballistic missile programs. The report is now being reviewed at GAO's top level. The agency hopes to submit it to Congress and make it public in early January. GAO undertook the investigation after USAF refused to make available the complete report made by the Air Force Inspector General after an agency investigation of ballistic missile management procedures (AW Nov. 16, 1958, p. 34).

Critchfield Withdraws

Dr. Charles L. Critchfield, $36,000-a-year director of scientific research for the Convair Division of General Dynamics Corp., has withdrawn his acceptance of an appointment as director of Defense Department's Advanced Research Projects Agency because of criticism of the plan which would allow him to continue to draw his Convair salary while serving in the key government post (AW Nov. 16, p. 28). Critchfield would have served without compensation in the $19,000-a-year ARPA position. The arrangement was clearly legal under a 1951 law authorizing Defense Department to obtain the services of a limited number of persons of outstanding experience and ability on a without-compensation basis and not otherwise available. Critchfield, however, decided that "general misunderstanding and public controversy have most certainly impaired my ability to serve." Defense Secretary Neil McElroy later said it was "most unfortunate that in this instance a situation . . . should have developed which will prevent the Defense Department from having the benefit of Dr. Critchfield's widely recognized scientific abilities in this important post."

Dulles: Soviet Threat Analyzed

Continued Soviet industrial growth at presently-forecast rates will "dangerously" narrow the gap between U. S. and Russia economies by 1970 unless U. S. industrial growth is substantially increased, Central Intelligence Agency Director Allen W. Dulles told a joint congressional investigating subcommittee last week. Dulles said future economic gains will provide the goods and the services needed to further expand Soviet military power as well as to push forward its economic penetration of neutral and underdeveloped nations of the free world. He pointed out that the major thrust of Soviet economic development and its high technological skills and resources are directed toward specialized industrial, military and national power goals, while the U.S. economy is largely directed toward the production of consumer type goods and services which add "little to the sinews of our national strength." Dulles also said fulfillment of the present Soviet Seven Year Plan is a major goal of Soviet policy and present indications are that Premier Nikita Khrushchev desires a period of "coexistence" in which to reach the objectives of the plan.

U. S. Helicopters for USSR

Soviet Union tentatively plans to purchase two Sikorsky S-58 helicopters and one Vertol Model 44 helicopter, according to Vladimir Alkhimov, commercial counselor at the Russian embassy in Washington. The detailed proposals of United Aircraft Export Corp. and Vertol Aircraft Corp. are now being reviewed in Moscow. An S-58, with numerous additions for safety and luxury, is used by President Eisenhower and first attracted the attention of Soviet Premier Nikita Khrushchev during his U. S. visit (AW Oct. 5, p. 25). It has a maximum capacity of 12 passengers. The Vertol helicopter, with a 19-passenger maximum capacity, is operated by New York Airways. Khrushchev's interest in the helicopter as an executive transport also resulted in a visit to the Kremlin's Ivan Square last week of a Soviet Mi-4 helicopter and its designer Milhail Mil. The helicopter was closely inspected by Khrushchev and deputy premiers Frol Kozlov and Anastas Mikoyan.

Full Scale?

A full sized USAF-Martin Titan intercontinental missile, which stands more than 100-ft. high on its display base, was mounted outside the convention hotel for the 14th annual American Rocket Society meeting here (see p. 26). According to a story making the rounds of the meeting, an American pointed out to a member of the Soviet Russian delegation that this was one of the United States' ICBMs. The Russian replied: "What scale model is that?"

—Washington staff

U.S. Space Officials Rap Lack of Urgency

White House attitude on military participation, need to compete cited by Pickering, Gen. Boushey.

By Evert Clark

Washington—Dissent over the confusion and lack of urgency in the nation's space program boiled over into public criticism from program officials last week, opening what is expected to be a turbulent year of more criticism, re-evaluation and probable reorganization.

For the first time, a key official in the civilian program directly challenged President Eisenhower's often stated view that the U.S. is not in a "space race" with the Soviet Union, and a key officer in the military program spoke out strongly on the military usefulness of space for peaceful purposes. Both the President and his scientific advisers often have expressed skepticism over the usefulness of space as a military sphere of operations and have attempted to put a civilian scientific tag on as many space projects as possible.

Strongest criticism of the current situation came from Dr. William H. Pickering in a luncheon speech at the American Rocket Society's 14th annual meeting. Pickering is director of California Institute of Technology's Jet Propulsion Laboratory which is now doing almost all of its work for the National Aeronautics and Space Administration.

"We should frankly admit that we are indeed in a race with the USSR," Pickering said. ". . . We must either pursue our space developments actively and successfully, or we must declare ourselves completely out of the space race."

When President Eisenhower was told at his Oct. 22 press conference that Maj. Gen. John B. Medaris had said the U.S. was "straddling the issue of whether we are competing with the Russians" in space, he replied:

"Now, this statement that we are straddling, as far as competition with the Russians is concerned, I don't know exactly what it means. I know this: "We have established and it has been published, at least in outline, a program of space exploration, and that has pointed out . . . some of the major things we want to do. Our planning is a positive one and I see no reason for thinking of it merely as competition with somebody else. It is something we intend to do."

No Space Program

Pickering said the U.S. does not have a space program now, if having a space program means having clear national goals, management and funds to support them on a long-term basis and public understanding of the importance of the program and the time and effort required to conduct it.

The Space Primer issued by Dr. James R. Killian, Jr.'s Presidential Scientific Advisory Committee just after the first two Soviet Sputnik satellites were fired listed four objectives for space exploration—scientific, commercial, military and human objectives—Pickering said.

"Now, it would appear to me the Killian Space Primer omitted the most important objective, and that is simply the objective to equal or exceed the achievements of Russia in space," Pickering said.

Real Objective

"If it is a race, one can ask the question, for what are we racing? Is it for military domination of space? Is it for scientific discovery? Or for commercial exploitation of space? Or is it for our national stature and prestige in the world?

"I believe the last reason is the most important, and not by any means solely for reasons of nationalistic pride but rather for very hard-headed, economic reasons."

Much of the rest of the world is asking whether the U.S. or Russia is the technological leader, Pickering said, and "as a consequence, many decisions affecting our economic welfare are being made against a background of USSR achievement and development in this area.

"As far as the rest of the world is concerned, it is perfectly clear that we are in a space race with Russia. . . . It is also perfectly clear that . . . we have not within these two years succeeded in matching Russian achievements."

Pickering sees "a lack of public understanding of the significance of our space program, of the necessity for the program, of the objectives of the program."

"I believe there is also a lack of broad governmental understanding of national objectives," Pickering said. "The questions of the relative priority of military and civilian programs are not clear; and, indeed, inter-service and inter-agency rivalry for scarce funds, facilities and manpower is certainly occurring."

When Pickering was asked at a press conference just who in government should admit that the U. S. is racing Russia, he said, President Eisenhower. He also said he did not clear his speech with NASA Administrator T. Keith Glennan because, as a NASA contractor and not a NASA employe, he did not have to do so.

Public Understanding

Pickering said he believes public understanding of the problem is "imminent" and indicated he thinks it is closer at hand than governmental understanding. "There are increasing signs that the public is vaguely discontented and embarrassed by our position in the space race, and that it soon will make its voice heard," he said.

Long-term goals "susceptible of engineering achievement and which will provide significant and dramatic progress in space" must be established, Pickering said. He cited as examples of such goals the Mercury project, landing a man on the moon, taking a closer look at the planets and landing a man on another planet and returning him.

It also is necessary to "clarify management responsibilities and priorities," he said. "We do not necessarily have to have a single space program, but we must clearly understand in what areas we can afford the luxury of parallel approaches and peripheral projects."

Next, he said, must come education of the public and Congress to "the realities and needs . . . not only the technical realities but also the realities of the time and money required." Pickering cited a newspaper survey that indicated three-fourths of the 2,000 people responding were "ashamed" of the relative U. S. position and that more than 50% said they were willing to pay an additional $50 a year or more in income taxes if the money went directly to the space effort.

Brig. Gen. Homer A. Boushey, USAF director of advanced technology, told the ARS meeting that "a military space capability must be developed and maintained as a matter of urgency for our national survival." In the debate over keeping U. S. space efforts "peaceful" —as the legislative act creating the civilian space agency requires—the term "military" has almost become a synonym for "unpeaceful," Boushey said.

Gen. Boushey has publicly expressed the military's views on space perhaps more often than any other officer. He was the first military man to pub-

licly suggest that there might be military usefulness to a base on the moon on the theory that it is desirable under military doctrine to hold the "high ground."

Consequently, Boushey has attracted perhaps more criticism from those who tend to favor a wholly civilian program than anyone else in the services. The Space Primer mentioned by Pickering indirectly attacked some of the ideas Gen. Boushey had expounded.

President Eisenhower was asked at a press conference last Nov. 4 why NASA was picked to be the "one missile and space agency" when it was comparatively new and had not done much of the development of missiles and space vehicles.

"Well, I think you . . . should be making a difference between missiles, by which we normally mean weapons, and space and the rocketry that will be useful in exploring the space," the President said.

"Now, I cannot for the life of me see any reason why we should be using or misusing military talent to explore the moon. This is something that deals in the scientific field, and to give this to the Air Force or Army or Navy, it just seems to me is denying what we really —a sort of doctrine in America. You have given to the military only what is their problem and not anything else. The rest of it stays under civilian control and that is the reason for having this agency."

This statement accurately reflects the thinking that has prevailed in formation of the civilian space program and particularly in recent transfers of rocket boosters and personnel from the military to NASA.

The first break in this pattern was the decision to leave the Dyna-Soar boost glide vehicle with the military, and some military observers hoped it meant the beginning of a better appreciation of the need for a military space program.

The President's Nov. 4 statement was expected to cause a decrease in public discussion of space by military men. Boushey said, however, that the question of whether there is a case for military space operations "is an honest question," asked by "sincere citizens; it has been partially answered in the negative by critics of the military, and I think it should be discussed clearly and frankly by the military."

Boushey likened the Midas early warning satellite and the Samos reconnaissance satellite—which have just been transferred to USAF along with the Discoverer program—to burglar alarms or policemen in space.

"They are not a threat to the peaceful world citizen anywhere," he said. "Further, I believe that military satellites and space weapons at least for the

Soviets View Man-in-Space Need

Washington—Soviet Union will place a man in space only when it encounters a task that automatic controls cannot perform, according to Soviet scientist A. A. Blagonravov, who says that thus far there is no need for manned space flight.

Blagonravov, a member of the presidium of the Soviet Academy of Sciences, told an American Rocket Society session he thinks manned space flight is technically feasible now, but that Russia will send a man into space only when it has some tasks for him to perform which cannot be performed by automatic instruments. He said that all present space tasks can be handled by automatic controls but that, when such systems cannot do the job, Soviet scientists will consider manned space flight.

Blagonravov termed reports of a training program for Russian astronauts, "ungrounded" and stemming mainly from journalistic imagination. He said Russia has no man-in-space program as such—just a program on research in flight safety. Blagonravov repeated earlier Soviet assertions that a man will be sent into space only when it is absolutely safe and when the re-entry and recovery system is proved safe.

Blagonravov's denial of a specific man-in-space program at the ARS meeting clashes with earlier statements by Prof. Andrei Kuznetsov, head of the Soviet aerospace medical program. Kuznetsov told delegates to the 52nd general conference of the Federation Aeronautique Internationale in Moscow last summer that the Soviets have selected four astronauts for their first manned space capsule program (AW June 22, p. 79).

Russians also recently released pictures of Soviet "cosmonauts" in training (AW Oct. 26, p. 66).

Asked whether he thought the U. S. and Russia should use joint communication facilities for such projects as the U. S. Mercury program, Blagonravov said it is "very desirable" to discuss such a concept, but he observed that differences in equipment might raise some difficulties.

Five-man Russian delegation to the 14th annual ARS meeting was headed by Prof. Leonid I. Sedov, chairman of the Soviet Academy of Sciences' spaceflight commission and president of the International Astronautical Federation. Other members were Blagonravov; Prof. Valerian I. Krassovsky, chief of the upper-atmospheric physics department of the academy's Institute of Atmospheric Physics; Vitaly G. Kostomarov of the academy's foreign department, and Yuri S. Galkin, interpreter and secretary for the delegation.

Sedov, Blagonravov and Krassovsky presented detailed reports on Soviet space achievements. Krassovsky said further study is required to explain the "somewhat higher currents between the electrodes of an ion trap" founded in the vicinity of the moon by the second Soviet moon rocket. He said that, although no magnetic field stronger than 50-100 gammas was found near the moon, "fluctuations of the magnetic field" were registered in space between earth and the moon and "further investigations will reveal whether these fluctuations really exist and what characteristics they have. Moreover, if they reflect real values of the magnetic field, frozen into the interplanetary gas, then it is the first direct indication of the interplanetary magnetic field."

Sedov gave the point of impact of the second lunar rocket as about 500 mi. north of the center of the visible lunar disk, south of the craters of Archimedes, Aristillus and Autolycus. He said the flight of the third lunar rocket from earth to moon was at an inclination to the equatorial plane of 55 deg. but that the moon's perturbation and subsequent perturbation by the earth produced a near-elliptic orbit inclined to the equator at about 80 deg. By the 10th revolution, the inclination is expected to be 48 deg., then increased to 57 deg. on the 11th revolution—which now is expected to occur next March and be the last before the probe burns in the earth's atmosphere.

"This effect (of sun and moon), though unexpected at the first glance, depends only upon Newtonian forces," Sedov said. "It is evident that such effects should be taken into account during theoretical analysis of problems concerning the structure of planet systems and the properties of the orbits of different planes and their satellites in the solar system."

Russians showed a composite picture made from photographs taken by the third probe and said the photographing "must be continued," and must include shots with side illumination from the sun, which would cause surface characteristics to stand out more clearly.

Sedov was quoted last week in the Soviet newspaper Pravda as saying radio contact with the third probe was lost after its principal tasks were "fully accomplished," possibly "as a result of a collision with a meteorite."

Blagonravov said orientation of the third probe was controlled by two pairs of jets for turning it around the longitudinal axis and one pair for turning it around each diametrical axis.

foreseeable future will primarily assist the defender and will be of relatively little value to a would-be aggressor. . . . A military space capability second to none is mandatory to the future security of the United States. And I believe a vigorous military space program will, more than any one endeavor, promote world peace."

On the West Coast, JPL's Dr. Eberhardt Rechtin, chief of the Guidance Research Division, told the Electric Club at Los Angeles that the U. S. has "dropped six months to a year further behind" in the last two years "in the process of organizing, re-evaluating, carving out paper empires and fighting over who is going to be the boss to tell the professionals what to do."

JPL scientists recently attempted to plan missions for a set of space vehicles for 1961 and 1962, Rechtin said, and when they had what they thought was a logical, technically sound program, they were shocked to realize that the goals in the first half of the program already had been achieved by the Russians.

Budget Rise Urged

The U. S., Rechtin said, should "quit being the straight man" for Russia and spend perhaps "the amount of money which Dr. Killian initially estimated—about $1.5 billion per year or approximately something less than 5% of our defense budget." Instead, he said, the NASA budget is "now somewhat less than what the U. S. pays to ship and store surplus wheat."

Russia spent probably $500 million to launch the first several Sputniks, he said, and as a direct result "the Russian technical prestige took a large discreet jump upward in the world market. Making a highly conservative guess of the cash value of this jump, based upon the size of the world market and the size of various governmental expenditures, the first several Sputniks meant a return on the world market on the order of $5 billion."

The nation needs clear goals, facilities, priorities, a very "hardboiled look" at the past performance of groups and willingness to let the professionals finally selected run their own race, Rechtin said. He said one of the most effective ways to do this would be to give both support and authority to NASA to do its legally assigned job.

Rechtin also took issue with the justification given for the lack of urgency —that the U. S. is in a scientific program, not a race.

"I have not yet figured out why coming in second in science is any different or better than coming in second anywhere else," he said.

Space Technology

Radio's Blackout During Re-Entry Probed

By Philip J. Klass

Washington—General Electric and Avco scientists seeking to eliminate the blackout of radio communications between ground stations and space vehicles or missile nose cones during atmosphere re-entry are exploring new telemetry radio frequencies at opposite ends of the spectrum, it was reported here during the American Rocket Society meeting.

Heavy attenuation of radio signals that occurs at regular VHF telemetry frequencies during re-entry is due to absorption of radio energy in the plasma, reflection of energy at the interface between the plasma and free space and in some cases to detuning of the vehicle antenna.

Radio data link which Avco is developing for space vehicle use will operate in the "extremely high frequency" (EHF) band above 30,000 mc. (30 kmc.), whereas General Electric is investigating the high frequency (HF) band, nominally 3 mc. to 30 mc., for possible use in re-entry communications.

Current knowledge of the problem indicates that a communication system operating at the lower end (HF) of the radio spectrum can penetrate the ionized sheath on vehicles that experience significant re-entry heating at lower altitudes, but a system operating at extremely high frequencies should be suitable for any type of vehicle, Avco's J. R. White said.

Signal attenuation due to plasma is drastically reduced when radio frequencies above 20 to 30 kmc. are employed. However, at frequencies of 50 to 60 kmc., signals suffer serious attenuation because of water vapor in the atmosphere. Frequencies above 70 kmc. appear ideal from the plasma attenuation viewpoint, but presently available components and equipment for operation at this frequency lack the required reliability, White said.

Avco therefore has selected the frequency band of 30 to 40 kmc. for the design of its new space vehicle communication system. White said the system is designed for communication with satellites, space probes and Dyna-Soar type vehicles. It will permit transmission of telemetry data, command control, compressed-bandwidth voice or radar data. System will have a data capacity of 1,000 samples per second, giving a data bandwidth of 800 cps., using pulse position modulation (PPM), or 400 cps. if provision is made to transmit a synchronization pulse. Prototype equipment is now being built.

GE's tests of HF communications system frequencies, sponsored by USAF's Ballistic Missile Division, will investigate 4, 7, 14 and 20 mc. using a 50 watt transmitter. Two types of antennas will be employed in flight tests. One, used on heat-sink re-entry vehicles, will consist of a center-fed two-inch slot antenna, 70 in. long, located in the surface of the metal afterbody in a plane containing the roll and yaw axes. For ablative vehicles, the antenna will consist of a center-fed slot formed by insulating an inner sphere-cone nose cap from the main body liner for seven tenths of the base circumference of the cap. The project was described by J. B. Duryea, E. F. Paski and W. L. Aseniero of GE's Missile and Space Vehicle Department.

Blackout of telemetry signals from the Atlas missile nose cone during the powered portion of flight appears to result from a combination of the plasma sheath and corona effects, Edward Niemann, Jr., of GE's Missile and Space Vehicle Department reported. The difficulty had not been encountered on earlier tests of the Thor intermediate range ballistic missile which used the same transmitters, antennas and re-entry vehicle configuration, probably because of lower booster velocities.

The abrupt decrease in telemetry signals occurred at about 260,000 ft. altitude followed by a sharp recovery of signal strength at 320,000 ft. altitude.

Tests thus far suggest that this may be due to a gas discharge (corona) around the telemetry antennas which results from the combined effect of their electric field and the ionization produced by high vehicle velocity.

Whether the ionization is due principally to heating of the air or heating of the antenna covers has not yet been established, Niemann said. He warned, however, that space vehicle communication system designers must take account of this source of communications blackout in addition to the other problems of voltage-induced corona and attenuation due to shock-wave-induced plasmas.

This year's ARS meeting had a larger number of reports devoted to avionic techniques and devices than in

previous years. Approximately 25% of the technical reports, not counting ion and plasma propulsion, were avionic in nature and about one out of six companies exhibiting at the show was an avionic manufacturer.

Highlights of other reports of avionic interest presented at the ARS meeting include:

• **Hovering satellite position sensing:** Four possible techniques for use aboard a hovering 24-hr. satellite to enable it to sense its longitudinal position and correct for any drift were reported by Rudy R. Mueller of North American Aviation's Autonetics Division. Mueller pointed out that an error of only one mile in establishing satellite radial position (altitude) can result in a longitudinal drift of more than 37 mi. per day, an undesirable characteristic for a hovering satellite intended for communication, navigation or reconnaissance service. The most attractive of the four techniques appears to be one called "solar sighting" which makes use of the fact that once every 24 hr. the sun, the satellite and the center of the earth should be on a direct line with one another. Using an electro-optical sensor to establish the direction to the sun and an inertial or electro-optical sensor to establish the direction to the earth's center, plus a moderately accurate clock, the system could establish the presence and magnitude of any drift from the desired hovering longitude. The solar sighting technique requires an accurate determination of the direction to the earth's center inasmuch as an error of one minute of arc results in an error of about 7.7 mi. in determining satellite longitudinal position. Mueller said, however, that this accuracy requirement does not appear too difficult to achieve.

• **Rotating pendulum accelerometer:** New type of precision accelerometer, especially suited for measuring slowly varying low-level accelerations of the order of 10^{-4} to 10^{-10}g was reported by Samuel Schalkowsky and Henry F. Blazek of Ford Instrument Co. The device uses a pendulum which rotates at a constant angular velocity in the absence of any external acceleration. If an external acceleration exists, pendulum will accelerate during one-half of its revolution, decelerate during the next half. The magnitude of the velocity change is proportional to the applied acceleration while the particular portion of the cycle in which the pendulum accelerates indicates the direction of the applied acceleration. Unlike conventional pendulum accelerometers which use null-balancing principles, the new device is not subject to error caused by change in spring constant or torque gradient, the scientists said.

• **Rubidium vapor magnetometer:** New type of instrument for measuring extremely weak magnetic fields sufficiently sensitive to measure interplanetary fields in space probe vehicles was described by J. P. Heppner of the National Aeronautics and Space Administration. The new rubidium vapor magnetometer developed by Varian Associates under NASA sponsorship will be flown early next spring in Javelin rockets. Miniaturized version, weighing less than three pounds and consuming less than three watts of power, is expected to be used in space probes before the end of 1960, Heppner said. Rubidium magnetometer has the advantage of lower power consumption and higher sensitivity in very weak fields (0.2 to 50 gammas) as compared with the older proton type device. In addition, the new instrument has shown considerable ability to measure superimposed oscillating fields of as little as 0.05 gammas.

• **Regenerative fuel cell:** Power source for space vehicles capable of supplying 550 watts continuously at 28 volts utilizing a closed-cycle nuclear regenerative fuel cell was proposed in a report by M. G. Del Duca, J. M. Fuscoe and T. A. Johnston of Thompson Ramo Wooldridge, Inc. The system would have an over-all thermal-electric conversion efficiency of 11%, would weigh approximately 216 lb. Proposed fuel cell would use liquid lithium and hydrogen as fuels reacting in the cell to generate electricity. Reaction products would be dispersed in the cell's metallic salt electrolyte which would be pumped to a decomposition chamber where they would be dissociated to the original fuels by application of heat from a small nuclear reactor.

• **Solar energy storage:** Use of the high heat of fusion of lithium hydride may provide a very efficient means of storing solar energy aboard a space vehicle for subsequent use when it is shaded from the sun, according to a report by C. L. Walker, J. D. Matchett and R. J. Harold of the Allison Division of General Motors. Solar heat from a collector would be stored by heating lithium hydride, converting it from solid to liquid form. When the vehicle is in the shade, the process would be reversed with lithium hydridge, giving up its heat to the working medium that powers a mercury vapor turbine engine or a Stirling cycle engine. Used with a mercury vapor turbine having an efficiency of about 10%, or a Stirling with an efficiency of 30%, it would give lithium hydride an over-all energy storage capacity of 14 to 42 watt-hours per pound, the researchers said. With improvements in heat exchanger design and lithium hydride purity, the figure may be raised as high as 60 watt-hours/pound. By way of comparison, batteries have a storage capacity of about four watt-hours/pound, fuel cells and flywheels have capacities of about 10 watt-hours/pound, they said.

Boeing Aims at STOL-VTOL Field By Proposing Merger to Vertol

Boeing Airplane Co.'s proposed acquisition of Vertol Aircraft Corp. is a move to complement its long haul aircraft capability by moving into the short haul and commuter type vehicle market.

Vertol, whose two previous merger discussions with Northrop Corp. and Bell Aircraft Corp. failed to develop, would become the Vertol Division of Boeing. Its shareholders would receive two shares of Boeing common for each three held of Vertol and Boeing would issue 449,000 shares or about 6% of the total Boeing shares now outstanding to make the transaction.

Both boards—but only Vertol shareholders—must approve the merger. Each stock reacted to the announcement by dropping in price: Boeing ⅞ of a point to 32¾ and Vertol from 22½ to 20¼.

Financial sources in New York regarded the chances for final approval as good since the actual stock exchange, a stumbling block in many such proposals, was agreed to. One company source was optimistic of the plan's approval, pointing out that the negotiations had resulted in a very solidly laid foundation, but he also noted the uncertainties involved in any acquisition plan.

Boeing's Product Research staff (AW Nov. 9, p. 56) recommended some months ago that Boeing get into the STOL/VTOL field as a major market with potential for substantial production of hardware. To do this, Boeing had the choice of developing its own capability or else bootstrapping itself into the market by the purchase of someone else's capability. Boeing chose the latter.

By moving into this area, one source pointed out, Boeing could be protecting its investment in the long haul jet business, based on the theory that the great improvement in speeds of jet aircraft might be nullified by airport-to-city delays or delays in connecting short haul services.

Vertol's two wholly-owned subsidiaries, Allied Research Associates and Canadian Vertol Aircraft, Ltd., would continue as separate corporations as Boeing subsidiaries. Vertol and its subsidiaries would retain their present managements.

NATO-Wide Research Project Proposed

Washington—Recommendation that the 15 North Atlantic nations join hands in space research was made by the science and technical committee of the North Atlantic Treaty Organization's parliamentarians' conference which met here last week.

The conference is composed of representatives of the legislative bodies of NATO countries. Its recommendations carry substantial weight, but are not binding on the NATO Council which will meet next month in Paris. The council is composed of the defense, foreign, and finance ministers of the member nations.

Sen. Henry Jackson (D.-Wash.), chairman of the science and technical committee, said in presenting the group's report to the conference that "there is nothing wrong with bilateral arrangements" for cooperative research in space "provided we do not stop there."

He added:

"The free world space effort is now like a football team with half its best players sitting on the bench. Scientists from every one of the 15 NATO nations possess skills which are urgently needed in space research. Yet this precious scientific talent is going unused because we do not have a cooperative space program."

Jackson said he welcomed the objective of a universal space program under the United Nations but pointed out that "years of talk and negotiation would be needed to make even a beginning at solving them."

White Views Space

Gen. Thomas D. White, USAF chief of staff, told the conference that satellite and space operations "clearly have tremendous strategic implications" for NATO. He said they indicate "that true global—perhaps I should say universal—capabilities are within grasp. As a result, they emphasize the vital requirement for strong free world military space capabilities."

Gen. White also implied that technological developments in weapons may eventually dictate the withdrawal of U. S. forces from the European land area.

He said:

"When the NATO strategy was first conceived, the sword's impact, in terms of time from the U. S., would not have been felt for 15 hr. or more. Today, the point of the sword could be on the target within 30 plus minutes. The difference lies in the capabilities of the propeller driven bomber compared with those of the intercontinental range ballistic missile."

Gen. White also predicted that these developments will have tremendous impact on future NATO strategy:

• **Airborne nuclear propulsion.** "Normally, when one things of airborne nuclear propulsion, one thinks only of nuclear-propelled aircraft. We think of aircraft which will have almost unlimited endurance and picture their offensive value when armed with air-to-surface missiles . . . The achievement of efficient and effective airborne nuclear propulsion will be expensive—in terms of effort and dollars. But, successful attainment of this objective will give us increased combat capabilities—and a stronger deterrent."

• **Nuclear rockets.** These, he said, will possess "tremendously increased thrust, which will make possible the launching of high payload satellites and surface-to-surface missiles."

• **Nuclear ramjets.** These "offer the promise of low altitude, high speed, long range missiles which could augment our strategic ballistic missile forces."

The specific recommendations of the NATO science and technical committee, together with Jackson's comments, were:

• **NATO center** for space studies should be established. "This need not, and should not, be a huge enterprise," Jackson said. "Such a center could be established at any one of a number of existing universities, laboratories, or research institutes, either in Europe or North America. It could serve as a common meeting place and focal point for space scientists from throughout our community."

• **NATO-wide space** "hardware" project should be developed. "In space research and technology there is no substitute for results—for 'hardware' successfully hurtling through space." Jackson said the first NATO-wide venture should be "a bolder and more ambitious enterprise" than an earth satellite program.

• **Inventory should be made of** the human and institutional resources available in the NATO community to support space research and exploration. "Much of this talent is now going unused," he said.

• **Greater interchange** and far closer cooperation in both basic and applied space research should be made. "Today's uncoordinated and independent national programs too often result in overlapping and duplication of effort," Jackson said.

Jackson also urged that an international conference of space scientists from the 15 community nations be convened early next year to start implementing the recommendations of the NATO committee.

F-104s Leave ADC

Washington—Air Defense Command will withdraw its total complement of Lockheed F-104A and B model day fighters from its active combat inventory early in 1960. About 150 planes are involved.

USAF officials indicated the principal reason for pulling the F-104 out of the Air Defense Command was its lack of all-weather capability, inability to operate within the SAGE system and relatively short range in relation to the North American air defense problem.

Lockheed F-104C and D fighter-bomber versions will remain in service with the Tactical Air Command. USAF said no firm plans had been made for disposition of the F-104s coming out of ADC. Indications were that they probably would be offered to the foreign military aid program, with the Chinese Nationalist Air Force based on Formosa as a likely recipient.

F-104s, mostly of the A and B day fighter models, have been involved in at least six accidents in the past few weeks. These were:

• F-104B of 337th Fighter-Interceptor Squadron at Westover AFB, Mass., crashed Oct. 27 during a return on instrument flight, killing two persons. Plane developed an asymmetric flap condition—a systems malfunction. This was the first accident for this squadron, which had recently won a flight safety award.

• F-104C at George AFB, Calif., flamed out over the gunnery range on Oct. 28. Pilot ejected upward and survived.

• F-104A crashed on Oct. 31 after takeoff at Dayton when the engine flamed out. Pilot ejected safely, but the plane crashed into a house, killing three children.

• F-104 had a power failure on takeoff at Dayton, reached a 10 ft. altitude, and the pilot aborted flight. He stayed with the plane, which is repairable, sustaining minor damage to gear. Air Force refers to this as an incident, rather than an accident.

• F-104B flamed out on Nov. 11 on takeoff from Hamilton AFB, Calif. The pilot ejected and plane went in. Gear was still down at time of ejection.

• F-104 was involved in midair collision in the vicinity of Tinker AFB, Okla., on the night of Nov. 12. Pilot ejected.

Second Titan B Try Scheduled This Week

Washington—Second attempt to launch an Air Force-Martin Titan B missile to test propulsion on both stages is tentatively scheduled for late this week. Titan thus far has experienced a 90-day delay between firings because of damage to a pad and procedural problems further back along the factory-to-launch-site pipeline.

A 40-day delay for repairs followed the explosion of missile B-5 at Pad 19 at the Air Force Missile Test Center's Cape Canaveral, Fla., launch site last Aug. 14. This was to have been the first test of second-stage propulsion.

Other preflight problems, including damage to one missile when the transporting aircraft lost pressurization, accounted for the rest of the delay.

Explosion of the B-5 is being blamed partly on a mercury rectifier in the ground equipment that was grounding itself electrically and partly on safety requirements that, in this case, turned out to be a disadvantage.

Job of the ground equipment item that failed was to receive a signal from the automatic master operational controller and then release energy to detonate the four explosive bolts that hold the missile to its launch stand. Because the equipment was faulty, it triggered the bolts prematurely.

Titan's first stage engines develop 70% of their thrust in the first second, but this immediate-launch procedure normally is not used in research and development firings. When the bolts triggered prematurely, the missile began lifting off the pad.

A safety factor built into the master operational controller for test launchings requires engine cutoff if umbilical cords do not disconnect simultaneously. Because of the premature liftoff, disconnect of one umbilical cord was lagging, and the signal was sent through the controller to kill the engine. The result was that the missile lifted 12 ft. and fell back to the pad.

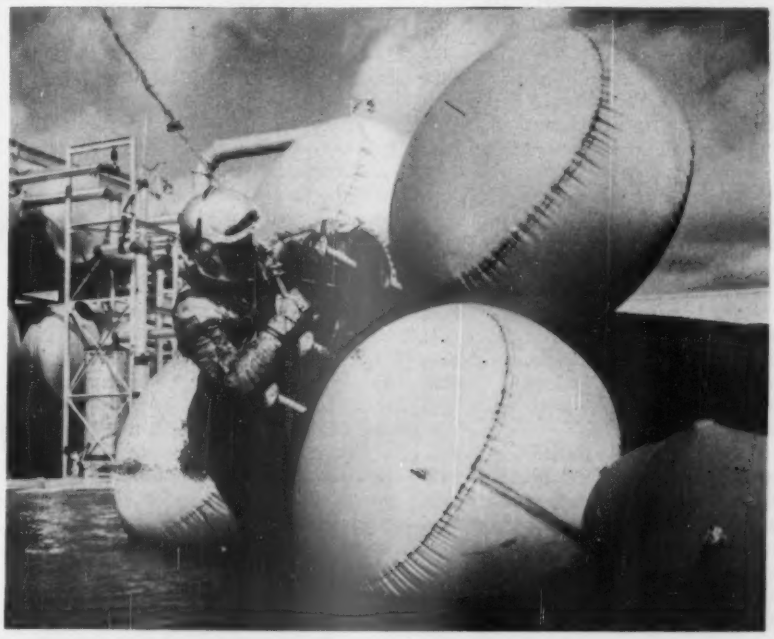
Analysis of engineering data indicates that the impact of the missile's fall set off an explosive primer cord that runs the full length of the two stages and is intended to destroy the missile on a signal from the range safety officer.

If the primer cord had not destroyed the missile when it did, damage to the pad might have been even greater. Recent explosion of the Atlas Able lunar probe launcher, caused by a propellant leak shortly after the engine was shut down following a short static firing, caused pad damage that is expected to take five months to repair.

The ground equipment that failed in the launch attempt has been redesigned, and the safety requirement eliminated.

Plastic Heat Shield Fitted to Mercury Capsule

Aluminum afterbodies of Little Joe Mercury test capsules are being fitted with a 1-in.-thick heat absorbing shield (above) composed of several layers of polyester resin-glass fiber compound, developed by Durez Plastics Division of Hooker Chemical Corp.; resin is designated Hetron (R)72. Below, McDonnell Aircraft engineer shows method of leaving the capsule in water. Flotation bags are automatically inflated on impact (AW Oct. 12, p. 29).



Solids Make Bid for Space Booster Role

By Michael Yaffee

Washington—Solid propellant rocket producers are making their first serious bid to move into the million-lb.-thrust-plus class and take on major space booster applications.

From information gathered at the 14th annual meeting of the American Rocket Society here last week, the major impetus behind this move appears to be the re-activation of the Air Force requirement for a million-lb.-thrust solid propellant rocket at a bidders conference two weeks ago.

Reactivation of this requirement, which was mothballed some months ago, reportedly because of possible conflict with National Aeronautics and Space Administration's big liquid engine program, follows closely upon the government's realignment of space responsibilities giving the Air Force cognizance over large military booster vehicles (AW Sept. 28, p. 27). Money which the Air Force originally set aside for this program is still intact and will be used.

Three Phases

The program is divided into three phases with a schedule that calls for completion of all three in less than five years. Phase I will be essentially a feasibility study and will involve the development and delivery of only three engines. At this point, there is no specific application spelled out for the engines being developed in this program.

Also, this program, which originally had a nominal goal of 1 million-lb. thrust, now has an indicated total impulse requirement of 20 million-lb.-sec.

All bids on Phase I are due in by Dec. 15, and it is expected that the Air Force will give a contract go-ahead as early as January. Bidders who were selected by the Wright Air Development Center Rocket Propulsion Research Laboratory—which is now being transferred to Edwards AFB, Calif.—are essentially the same companies that submitted proposals on the project seven months ago (AW May 4, p. 23)—Aerojet-General, Thiokol, North American Aviation, Grand Central Rocket Co., United Aircraft Corp. and Hercules Powder Co.

Since it omits any mention of potential applications and substitutes the total impulse figure for a specific total thrust requirement, the Air Force program is believed to be an attempt at avoiding a conflict with NASA as well as an effort to give bidders more leeway in formulating their proposals. In effect, the Air Force is simply asking bidders for proposals on a solid propellant rocket engine that will contain a little over 80,000 lb. of propellant, based upon the present-day solid propellant's capability of delivering between 240 and 250 sec. of specific impulse. If the Air Force had specified instead a total thrust of 1 million lb., this would mean that the same rocket engine would then be limited to a burning time of 20 sec.

However, specific impulse of solid propellants can be varied, and, by not having any indication of specific applications or missions for the engine, the bidders have no way of knowing whether they will need or should base their proposals on high specific impulse propellants or not.

Although the initial phase of the program calls for the delivery of only three engines, the contract is considered highly desirable and important by the bidders who regard it as representing the next major step in the solid propellant rocket field. The company that gets this contract, the bidders believe, will have a substantial competitive edge in the future development of large solid propellant rocket engines.

It is too early to pinpoint the design of the 20 million-lb.-sec. engine, but there are some aspects of this new booster program about which most of the bidders seem to be in general agreement. These include:

- **Essentially,** the program will involve the scale-up of existing solid propellant engine capabilities rather than the development of new ones. Current solid propellant engine that comes closest to matching over-all weight, dimensions and performance of the new 20 million-lb.-sec. engine is the first stage powerplant of USAF's Minuteman, followed by the Nike Zeus booster and the Scout first stage motor. The Minuteman first stage engine contains roughly half the propellant weight that will be required in the new 20 million-lb.-sec. engine. The Zeus booster, which has a thrust of approximately 450,000 lb., contains less propellant than the Minuteman first stage, has a much shorter burning time and has only about 25% of the total impulse of the first stage Minuteman engine. The Scout first stage engine contains between 19,000 and 20,000 lb. of propellant which has a delivered specific impulse—as does the propellant in the other two engines—of somewhat under 250 sec.
- **Some of the bidders** believe they could deliver the first of the new engines to the Air Force within a year. Others, who take a more conservative view, believe they could carry out the first static firings by that time and could make delivery somewhat later.
- **Total weight of the new** engine is expected to be approximately 100,000 lb., well within transportation limits and therefore not requiring on-site propellant loading. Engine will be shorter but will weigh more than a comparable liquid propellant engine.
- **Propellant grain** will have sufficient strength to support itself without the aid of reinforcing rods.
- **Some bidders will base** their proposals on double-base propellants, others on composites. Those making bids with composites say presently available polysulfide or polyurethane fuel binders can do the job, but at least one major bidder will not include either of these in its proposal.
- **Engine nozzle or nozzles** will be scaled-up versions of the newer types now in use which have ablative plastive exit cones. At present, there does not appear to be a need for a metal backing for the nozzles unless some outside load is imposed on them.
- **Engine will not have** throttlability or restart capability, but proponents of solids point out that large liquid propellant engines now in use and under development do not have these either.
- **Engine casing,** due to the somewhat tight timetable for the project, probably will be fabricated from steel. Most contractors feel there would not be time to bring titanium to the point necessary to be considered as a casing material for this project, even though the design engineers are definitely enthusiastic about the material.

Program Cost

Because of the fact that there apparently is no actual need for new developments, the contractors do not consider the project timetable as overly tight for the technical problems involved. For United Aircraft—the actual bidder will be its West Coast subsidiary, United Research Corp.—the lack of large solid propellant rocket facilities could prove to be a timetable obstacle and has given rise to speculation that the company might buy an established rocket company to get the facilities.

On other aspects of this project, principally cost, there is some disagreement among the bidders. One of the companies involved feels that the total cost of the program will prove competitive with those entailed in the production of a comparable liquid propellant engine provided the solid development program proves to be less complicated and less costly through, for example, considerably fewer test firings. Balanced against this expected

lower development cost is the higher cost of solid propellant materials and processing. At the other extreme, one bidder believes it could do the development job for roughly 10% of what it would cost to develop a comparable liquid propellant engine. If reliability is designed into the engine, another bidder believes, complicated and costly engine testing can be eliminated.

Another area of disagreement is the time at which this program could have been begun. Some believe it has been technically feasible since 1951. Others say it would not have been technically feasible five years ago to build such a large solid propellant rocket because the mechanical properties of the fuel binder were not good enough to prevent cracks from forming in the grain.

There is agreement, however, that the 20 million-lb.-sec. engine is nowhere near the ultimate in large solid propellant rocket engines, particularly for space vehicle work. John Gustavson, of Grand Central Rocket Co., gave some indication of things to come in future solid propellant space applications and, possibly, in Grand Central's Dec. 15 proposal to the Air Force, in a report on the use of multi-million-pound-thrust solid propellant boosters.

Gustavson proposed two solid propellant space launchers. One would have an initial thrust of 2.4 million lb. and be capable of placing a 26,000 lb. payload into a 300 naut. mi. orbit. The other would be a cluster of six of these engines with an initial thrust of 14.4 million lb. It would put a 150,000 lb. payload into a 300 naut. mi. orbit.

On the basis of these two boosters, Gustavson hypothesized two three-stage space vehicles which he designated Cronus and Novus. The Cronus would use the single booster with the second and third stages on top. It would have a total weight of 956,000 lb. and an over-all length of 175 ft. The 26,000-lb. payload would sit on top of the third stage.

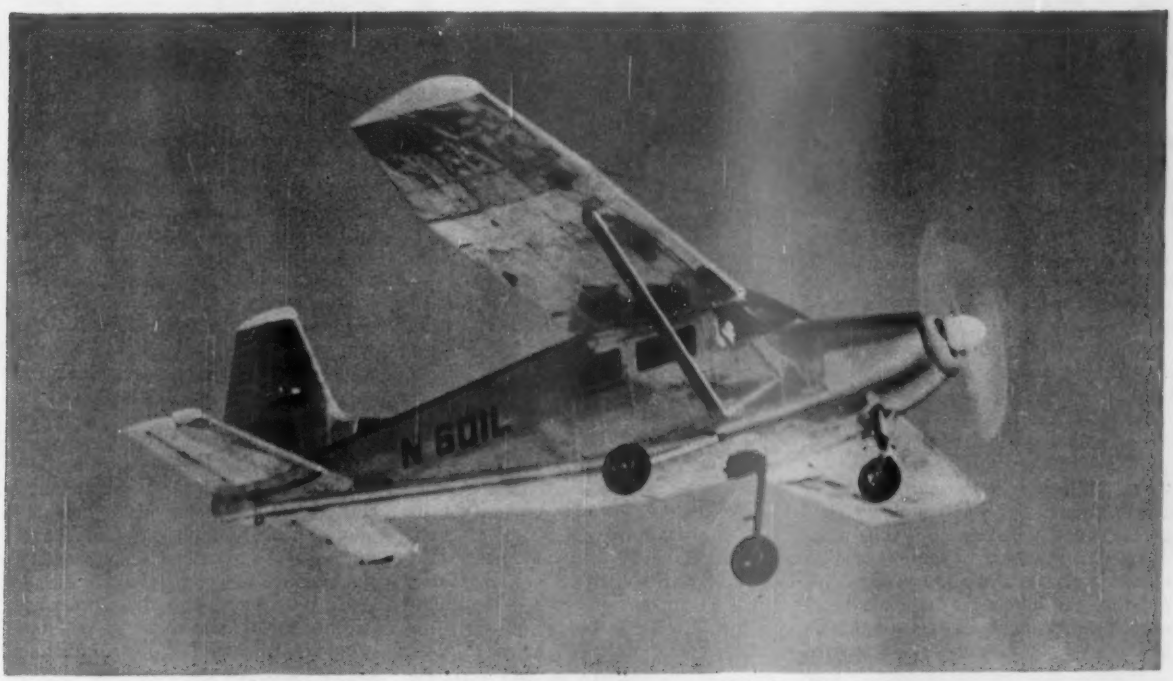
The Novus would use the six engine booster clustered around the second stage. On top of this would go the third stage and then the 150,000-lb. payload. Total weight would be 5,177,-000 lb.; over-all length 155 ft.

The Cronus booster, as proposed by Gustavson, will be 90 ft. long, 12.5 ft. in diameter and weigh 691,000 lb. It will have a burning time of 72 sec. and produce a thrust of 2.4 million lb. Novus booster will be 90 ft. long, 38 ft. in diameter and weigh 4,145,000 lb. It will burn for 72 sec. and produce a thrust of 14.4 million lb.

The propellant Gustavson would use in his boosters is the Nitrasol propellant developed by the Naval Ordnance Test Station and Grand Central Rocket. Propellant binder consists of nitrocellulose plus one or more high energy plasticizers. For added energy, the propellant is formulated with ammonium perchlorate and aluminum. The propellant, according to Gustavson, has a delivered specific impulse above 250 sec. and costs approximately $1 per pound as compared with 45 cents per pound for conventional composite solid propellant, 36 cents/lb. for storable liquid propellants, and 2 cents/lb. for the cryogenic liquid oxygen-RP-1 combination.

The large size of the engines means that they probably would have to be loaded—and the engine casing probably fabricated—on site. The ignition or detonation hazard in mixing the propellants is minimized by the small amount of propellant being mixed at any one time and by an automatic emergency shutdown system in the mobile continuous mixer, all proposed by Gustavson.

High tensile strength steel would be used for the rocket engine casing. The nozzle would be a lightweight, ablative plastic unit such as the one developed by Douglas Aircraft Co. This is a single unit of composite construction consisting of converging and diverging sections of filament-wound, glass-fiber-



Lockheed 'Bush' Plane' Starts FAA Testing

First flight photo of No. 1 prototype of Lockheed's Model 60 "bush plane" shows tricycle gear designed for plane's intended rough field operations in Mexico and other Latin American countries. Second prototype now is under construction at Lockheed's Georgia Division. Plane will be built in Mexico City by Lockheed-Azcarate (AW Dec. 22, 1958, p. 41). Prototype powerplant is a 260-hp. Continental IO-470 air-cooled engine with fuel injection; future plans include testing engines fitted with superchargers. Cabin is convertible from six-passenger configuration to cargo. Dimensions are: wingspan, 40 ft.; fuselage length, 28 ft., and vertical tail height, 10 ft. 8 in. Federal Aviation Agency certification tests are under way.

reinforced plastic with a wound-in throat area of Refrasil oriented silica fibers in a plastic matrix.

Thiokol's Harold W. Ritchey, in a recent design and cost study of a 10 million-lb.-thrust solid propellant engine, covered many of the factors involved in making a single, solid propellant rocket engine much larger than any yet considered.

The engine, which would have a burning time of 60 sec., would be 107 ft. long, 20 ft. in diameter and weigh 3 million lb. It could put a 60-ton payload in a satellite orbit or a 20-ton payload on the moon. The large size of the engine would necessitate on-site propellant loading and engine fabrication unless the casing could be transported by barge.

Development of new engineering techniques for on-site fabrication would be the only new development needed. The rest, again, would be a matter of scaling up existing components. Development time up to the first flight would be about three years; cost up to the first flight would be approximately $70 million. Cost of each engine in the production stage is estimated at $4 million.

Plastic Units

Propellant grain would not require any reinforcing rods for support. Nozzles would be scaled-up versions of plastic units Thiokol has developed in a team effort with a number of other companies.

Although the subject of this study appears to be considerably beyond the requirements of the reactivated Air Force booster projects, some parts of the study itself could be adapted to fit into Thiokol's Dec. 15 proposal. More likely possibility, however, is that the study will probably be turned into a proposal as is for presentation at a later time.

Aerojet, while unwilling to make definite projections much beyond the level sought in the present Air Force requirement, agreed that 1 million lb. thrust does not approach the limit attainable with solids. So far as the safety problem is concerned in putting a man on top of a solid propellant engine, Aerojet's Richard Goeckler conceded that it would be extremely difficult to catch an explosion in time but felt that the inherently high reliability of solid propellant engines might be counted on to offset this problem.

William Pennington, of Space Technology Laboratories, discussed the growing need for and problems involved in static testing under altitude conditions. Occasioned by the increasing importance of space work, numerous static engine tests are now being run under altitude conditions and already have demonstrated, among other things, important differences between sea level and altitude ignition of both liquid and solid motors as well as unsuspected effects of low ambient pressure on the burnout of solid engines and the shutdown of liquid engines. This is still a new area, Pennington said, and needs further development of testing methods before its full potential can be realized.

Rocketdyne's S. F. Iacobellis made a detailed comparison of two 1.5 million-lb. thrust liquid propellant rocket engine systems, one a single chamber engine and the other a cluster of eight proven or partially developed engines. From this study, he drew the following conclusions:

- **Single chamber engine** has a higher ultimate reliability than the eight engine cluster but use of a ninth engine as a spare boosts cluster reliability to a competitive level.
- **If the same starting date** is assumed for the development of the new single engine and the clustering of eight established engines, the cluster can achieve a system reliability of 0.9 one year sooner. Provided with a spare, the cluster will have a two-year lead toward a system reliability of 0.95.
- **Single engine normally** will be more advanced and can be expected to have a booster payload advantage which, in this example, was calculated to be 10% for a three stage liquid oxygen-RP-1 missile.
- **Development cost** is much lower for the cluster since the major portion of engine testing can be carried out with the small individual component engine. Production and over-all operational maintenance costs, however, probably will favor the large single engine.
- **Mission condition will determine** which engine system is selected. The cluster probably would be the choice for research programs requiring early availability of a small number of boosters at a new thrust level, owing to the cluster's two-year advantage in availability and its lower development cost. For long-range military programs requiring several squadrons of operational vehicles, the single engine probably would be chosen because of its higher ultimate reliability, superior performance and lower operational costs.

J. P. Hynds and C. J. Kaplan, also of Rocketdyne, approached this same area from the standpoint of safety and reliability for manned payloads. Time and cost considerations, they said, will necessitate the use of engines for manned applications which do not have the safety and reliability desired.

To improve upon this, they evaluated a number of approaches that would significantly improve manned safety and reliability but that, at the same time, would detract from over-all mission reliability. In order to raise manned reliability as much as possible, while holding the increase in mission aborts to a minimum, the two engineers proposed the use of five simple safety measures which look particularly attractive for the clustered liquid rocket engine system. These are an "engine ready" indicator; provision for hold down; "Thrust O.K." indicator (to show proper operation of all engines prior to release); combustion stability monitor; turbine overspeed or gas generator overtemperature monitor, and provision for fire detection and suppression. Eventually, Hynds and Kaplan said that large liquid engines may achieve individual reliabilities against catastrophe of 0.999-plus and preclude the necessity for safety devices even on clusters.

On the subject of safety and reliability of liquid rocket engines for manned flight, Aerojet-General's James Madden emphasized the point that multi-engine liquid rocket clusters in which one or more of the engines may be considered redundant appear to offer the highest reliability and safety for manned space vehicles.

More specifically, Madden feels that a cluster of seven to 10 engines in the 100,000-200,000-lb. thrust range would provide the best immediate booster system for manned flight. In a 10-engine cluster with one engine totally redundant, Madden estimated that it will be possible to achieve a reliability of approximately 93.5%. Making two engines totally redundant would raise this reliability figure to slightly over 96% without significantly impairing over-all vehicle performance, he said.

Madden also believes that it is absolutely necessary to incorporate automatic monitoring and engine shutdown devices in the system to achieve the high reliability available from redundant engine clusters. At the same time, he disagreed with Hynds and Kaplan on the need for engine fire indicators. Madden feels that such devices are entirely unwarranted and would, in fact, prove hazardous, because the resultant shut-down would often be caused by a false indication and hence reduce the pilot's over-all safety probability by removing the survival factor provided by the engine.

He does agree with the Rocketdyne authors on the advisability of providing a hold-down period. For an individual engine, Madden said a short hold-down period of roughly 3% of the total engine operating duration would make it possible to eliminate over one-third of the total potential failures from in-flight safety hazards and would be worth the accompanying slight reduction in over-all performance.

Nuclear Auxiliary Space System May Be Operational Within Year

By Craig Lewis

Washington—Small nuclear auxiliary power system designed for space vehicles is currently running in prototype form and is expected to be operational within a year.

The experimental reactor is designed to produce heat for a three kilowatt power system that will operate for one year. Built by Atomics International Division of North American Aviation, the reactor has been tested at design power and temperature at a company-operated AEC facility in the Santa Susana Mountains north of Los Angeles.

SNAP reactor was developed for AEC's Systems for Nuclear Auxiliary Power program under the SNAP II concept. It parallels SNAP I and III programs based upon use of radioisotopes to operate power conversion equipment. SNAP II experimental reactor system was developed under a $6.5 million AEC program, but production units are expected to cost about about $400,000.

AEC Chairman John A. McCone estimates that the SNAP II reactor and power conversion system will be in operational form as an auxiliary power unit within a year. He described the new development to a session of the American Rocket Society last week. He also reported progress in these fields:

• **Project Pluto nuclear ramjet** program is progressing rapidly and "our scientists are so sure of success—despite technical problems yet unanswered—they are willing to forecast not only when the demonstration unit will be proven on land but also when the ramjet will be ready for operational use."

• **First experiments** with Project Rover nuclear rocket program using hydrogen fuel confirm theories concerning the very high specific impulse attainable with nuclear energy. McCone said it appears from both theory and actual test that "the fantastic energy of the atom—the very high specific impulse obtainable—can be used successfully in a rocket engine."

• **Development of a nuclear-powered** aircraft is important, and "it must be brought into useful reality in the shortest possible time." McCone said it is desirable to choose the most promising of the two concepts currently under study for nuclear aircraft power and to concentrate on it. "This is one of the tough decisions that needs to be made—and soon—and we as a nation must face up to it with resolve."

SNAP II experimental reactor is housed in a cylinder 14 in. in diameter and 18 in. high, and it weighs 220 lb. without shielding. The reactor is fueled with enriched uranium. In the power conversion system, heat from the reactor will be transferred through a liquid sodium coolant to a boiler where it will vaporize mercury, and the mercury vapor will drive a turbine. Mercury in the closed circuit system also lubricates bearings in the power generation system.

Turbo-generator in the power conversion system weighs about 30 lb. Mercury vapor-driven turbine drives a generator to produce the three kilowatts of power. Life of the system is basically limited by the life of the moving parts in the conversion system. Components were developed by Thompson Ramo Wooldridge, Inc.

McCone said the SNAP II reactor is the smallest known operating reactor in the world by a substantial margin. In its operational form, the nuclear auxiliary power system will go into operation in space when the reactor is activated by a ground signal. Signal will not be sent until a successful long-lived orbit has been established for the space vehicle carrying the system.

This factor makes the SNAP II system safer than the radioisotope before and during launch because the reactor is cold until signaled, while the radioisotope is continuously hot. Both present problems on re-entry when they might contaminate the atmosphere as their carrier vehicles burn up.

Possible X-15 Fix

Washington—North American Aviation, Inc., may change the damping which controls the rate of spread of X-15 research aircraft's rear skids. Indications are that this may be the best fix to correct a touchdown problem that has come to light in the flight test program thus far.

Apparently, certain design criteria for the plane's landing gear have turned out to be deficient, according to the flight test results. Damping was low on the first flight, when the aircraft contacted the ground at the bottom of one of the pitching oscillations which developed late in the final approach and were increasing in amplitude. Problems arose as a result of this incident.

After the plane sustained structural damage through failure of a fastening during recent emergency landing on Rosamond Dry Lake (AW Nov. 9, p. 34; Nov. 16, p. 32) and it was ascertained that the landing was made within the prescribed limits of airspeed and sink rate—although the airspeed was the lowest of any landing yet—it was indicated that some sort of fix is needed in the landing gear system.

Rate of spread of the two skids at the rear also influences the rate at which the nose is pitched down and contacts the ground.

News Digest

Soviet Premier Nikita Khrushchev told a meeting of Soviet journalists last week that "250 rockets with hydrogen warheads came off the assembly line of the plant we visited in one year," and said his recent disarmament proposal was not based upon military, political or economic weakness.

Scheduled strike of Trans World Airlines hostesses set for Nov. 18 was averted last week when the carrier and Air Line Stewards and Stewardesses Assn. agreed to arbitration.

Piasecki Aircraft Corp. will develop a successor to the VZ-8P aerial jeep. New vehicle, designated 59-H by Piasecki, will have slightly larger fan blades which will be tilted to permit higher speeds. Blades will be metal instead of wood, and advanced dual control system will be installed. Powerplant will be two 425 eshp. Artouste II-C gas turbines; VZ-8P has one Artouste II-B (AW May 11, p. 32).

General Electric's Military Electronics Department was awarded a $24 million USAF contract for production of its AN/FPS-24 radar capable of detecting supersonic aircraft at long range despite interference and enemy countermeasures. The radar will be tied into the SAGE system.

Flying Tiger Line will sell $5 million in 5½% convertible notes to the New York Central Railroad for the purchase of new equipment. Notes are convertible to common stock at $20 per share for 10 years and $25 per share for five years thereafter. Proceeds, which will be drawn down in 1961, will be used to purchase aircraft in addition to the 10 Canadair CL-44D turboprop all-cargo transports now on order.

National Aeronautics and Space Adminsitration's Project Tiros meteorological satellite is scheduled to be boosted into a 400 naut. mi. circular orbit on Jan. 12 from Cape Canaveral, Fla. Payload may carry up to three television cameras with varying degrees of viewing resolution. Radio Corp. of America is furnishing the payload under Army Signal Corps contract.

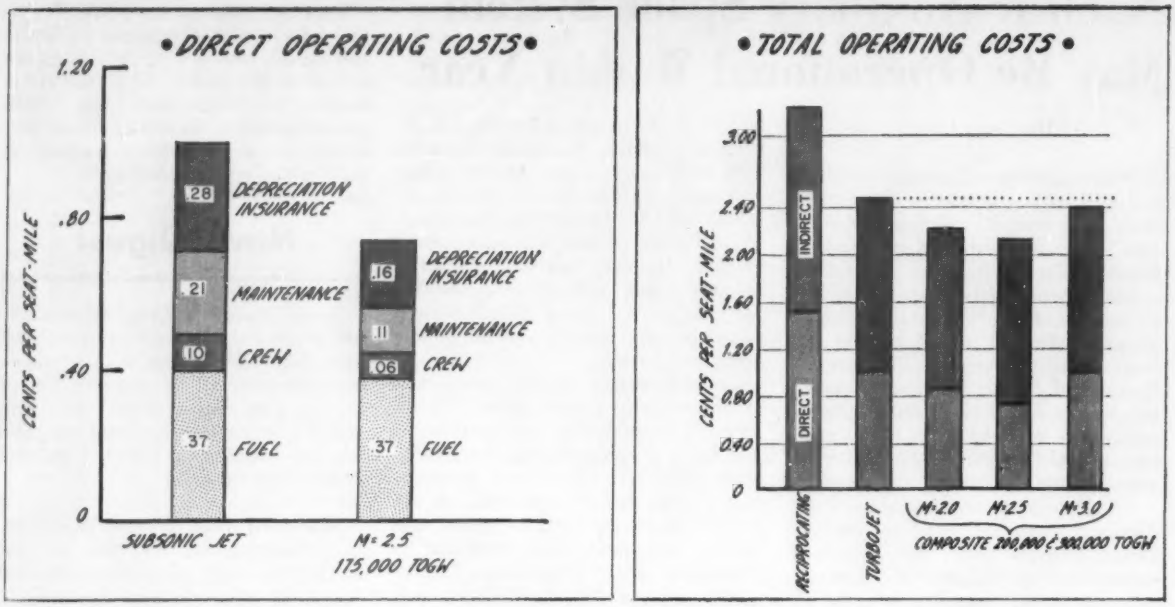


CHART at left shows sharp drop in Mach 2.5 jet maintenance costs; at right is comparison of operating costs of three types.

Study Predicts Mach 2-3 Transport Costs

ARDC-sponsored project concludes that fuel will be major item; greater productivity is also cited.

By William S. Reed

Los Angeles—Supersonic transports, designed and built with today's technology and using conventional fuel, may find their most economical cruising speed in the Mach 2.5 to 3 range.

Such aircraft would be nearly 20 times as productive in a military logistics role as the Douglas C-124 Globemaster. Similarly, the supersonic vehicle would prove more productive than reciprocating or subsonic turbine-powered transports in a commercial role, according to a recent study by Planning Research Corp., Los Angeles, under contract to Air Research and Development Command.

No attempt was made in the study to assess the feasibility of developing such a transport, but rather the focal point of the study is the economic aspects of operating such a vehicle.

Main Objectives

The study was undertaken to fulfill these main objectives:

- **Provide a comparative analysis** of reciprocating, high speed subsonic turbine transports and supersonic transport aircraft both in the military system and in commercial airline operations.
- **Forecast potential demand** for supersonic transports in the domestic and world-wide commercial markets.

As an adjunct to the study, and also to provide a tool with which to assess the problem, Planning Research Corp. developed a method of estimating direct and indirect operating costs of current and projected transport aircraft, both military and commercial. A parametric analysis approach was used on a generalized family of supersonic transports, design and performance characteristics of which represent the spectrum of designs proposed by airframe and engine companies.

Parameters for the generalized supersonic transports fall within the following limits:

- **Takeoff gross weights** between 175,000 to 700,000 lb.
- **Design speed** of Mach 1.5 to 3.5.
- **Design ranges** of 1,000 to 4,500 naut. mi.

No attempt was made to optimize a particular supersonic aircraft design or to provide a comparative evaluation of particular designs. The goal was to provide a relative cost comparison covering the entire spectrum of proposed supersonic transports. Cost comparisons made show the effect on operating costs as: (1) takeoff gross weights are varied (2) designs speeds are varied, and (3) design ranges are varied. A comparative cost analysis also is made between these parametric transports and current subsonic transports.

Forecasts of the commercial air traffic volume in the 1960-1975 era also have been made in order to predict the potential commercial market for supersonic transports.

Cost Comparisons

Cost methods, devised to permit the comparative cost analysis between present aircraft and the projected supersonic transport, allow valid and reliable relative cost comparisons to be made, according to the study. Six items are considered in order to form a basis for cost projection. In most cases, historical trends are considered and the figures then extrapolated to fit the supersonic transport era.

Crew costs are determined by analyzing the manning policies of the Military Air Transport Service in the case of the military transport and by analyzing the trends occurring between aircraft productivity and crew salaries as determined by discussion with airline and Airline Pilots Assn. personnel. The analytical results provide a basis for extrapolating crew costs into the future.

Maintenance costs are projected by

using as a basis the relationships developed for subsonic jets and reciprocating transports with the analysis of correlations frequently used to predict maintenance costs. Additional information was gained from airframe and engine manufacturers (e.g. engine maintenance guarantees, aircraft design characteristics) and the consideration of operational factors which may affect maintenance costs peculiar to the high speeds at which the aircraft may operate. Also considered are labor costs projected from the historical relationship between aircraft empty weight and labor costs and the historical relationship of aircraft flyaway costs to material costs.

Fuel cost estimates are based on the world-wide into-plane price for the USAF or, in the case of the airlines, that price charged for JP fuel in large quantities plus an allowance for a two cent per gallon federal tax. In determining fuel cost, Mach numbers from 1.5 to 3.5 with lift-to-drag ratios of 9.5 to 7.0 were considered with specific fuel consumptions for both afterburning and non-afterburning aircraft.

Depreciation is estimated by analyzing initial aircraft costs as projected by the aircraft industry. Depreciation costs are based on a procurement program of 100 aircraft having a 10 year useful life.

The study also assumes a 10% residual value for both the aircraft and spares. For the military transport, a 6 hr. daily utilization is assumed and for the commercial version, 8½ hr. daily utilization.

Attrition rate for the military transport and insurance costs for the commercial version are projected by analyzing historical trends in the Air Force and by analyzing historical trends in insurance rates for commercial airlines. These costs were, in turn, extrapolated to the time period considered in the study.

Indirect costs were established by studying historical relationships between direct and indirect costs in both MATS and in commercial airline operation.

Economic feasibility study of a supersonic military transport brought Planning Research Corp. to the following conclusions:

• **Fuel costs** will be the most significant operating cost factor at supersonic speeds. Improvements in fuel consumption will significantly improve efficiency in terms of operating costs per available ton mile of the supersonic transports.

• **Productivity** of supersonic transports at Mach numbers from 2.5 to 3 represents significant gains over the productivity of present day subsonic transports.

• **Selected operating costs,** with design range and design speed held constant, decrease as the takeoff gross weight of the supersonic transport increases because of the consequent increased payload capability. This does not allow for frequency of service requirements or the attainment of economic load factors, both of which must be considered in optimizing a specific transport size.

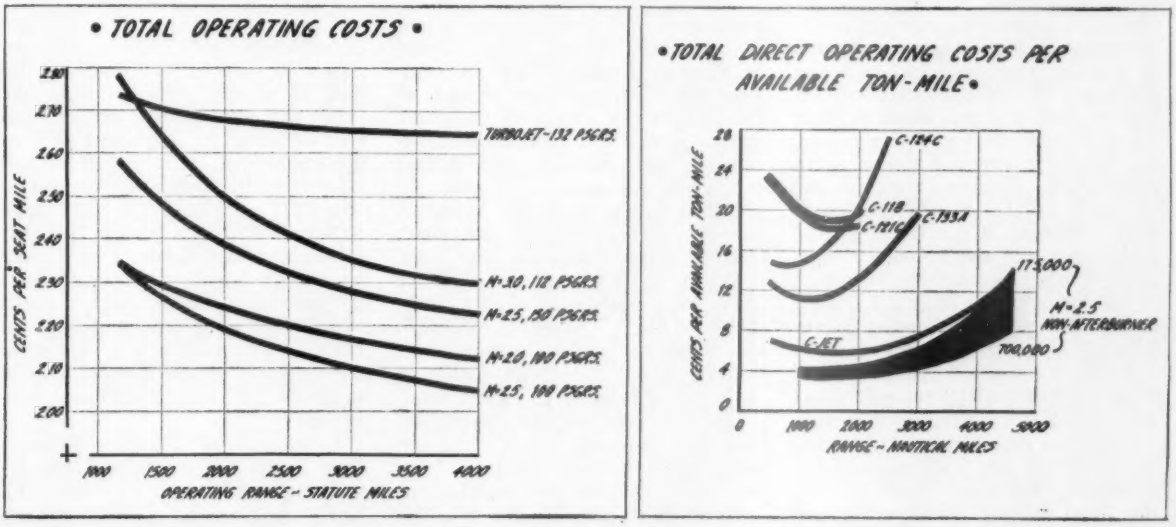
• **Mach 2.5** appears to be the most efficient speed for supersonic transports assuming constant takeoff gross weights. Basis for this conclusion are present operating and design characteristics, particularly specific fuel consumption, and does not measure the fact that future technical advances will benefit operating costs at Mach 3 relatively more than those at Mach 2.5. Specific aircraft development programs should, therefore, consider speeds in the area of Mach 3, as well as those in the area of Mach 2.5, in order to take advantage of the greater growth potential at the higher speed.

• **Superior efficiency** of the supersonic transport is evident when measured in terms of operating costs per available ton mile, particularly at speeds in the area of Mach 2.5. Supersonic transports at speeds in the area of Mach 2.5 appear to be more efficient than advanced subsonic cargo jet transports. Even at speeds in the area of Mach 3, supersonic transports appear to be competitive with the swing-tail cargo jets except at extreme ranges.

Productivity of various transport aircraft was determined in order to develop a cost per available ton mile per hour so that economic comparisons among military transport aircraft could be made. Increase in productivity of the supersonic transports is apparent from the analysis made by Planning Research Corp. As an illustration, for aircraft of approximately the same takeoff gross weight and at a range of 3,000 naut. mi., productivity of a Mach 2.5 transport is about 20 times greater than a Douglas C-124 Globemaster.

Comparison also is made between aircraft initial cost and available productivity. Initial cost per ton mile of available productivity was obtained by dividing the initial flyaway cost of the aircraft by the available ton miles at the range indicated. This example shows the value of speed and the decreasing initial cost of productive capacity as speed increases. For example, initial cost per available ton mile per hour of the C-124 was approximately $1,180, while in the family of supersonic transports studied by Planning Research Corp., the figure is estimated at $277.

The study also concludes that with



SEAT MILE costs drop when plane gets into Mach 2.5 envelope (left). Mach 3 planes (right) have lower operating costs than USAF aircraft.

design speed and design range held constant in the family of supersonic transports (both afterburning and non-afterburning), efficiency increases as takeoff gross weight increases. Effect of decreasing costs with increasing takeoff gross weight results from the fact that although hourly costs of operation are increasing as the aircraft becomes larger, productivity increases at a much more rapid rate.

This analysis is based strictly on available ton-mile productivity. No consideration is given to load factors or other qualitative factors, such as frequency of service, both of which factors may tend to support smaller transports. In selecting a particular takeoff gross weight, consideration must be given to these factors. However, optimizing aircraft size was not within the scope of the study, which is designed only to measure the relative effect on costs with variations in the design parameters considered.

Fuel Costs

Fuel costs become a more significant part of selected direct operating costs as the speed of the supersonic transport increases. Whereas fuel costs represent about 26% of the selected direct operating cost of a C-124, fuel represents 65 to 70% of the selected direct operating costs for a Mach 3 transport.

Although the study indicates that Mach 2.5 appears to be the most efficient speed from a cost standpoint, considerations directed at specific aircraft research and development programs must take into account the fact that, as technical advances are made, Mach 3 will rapidly become a relatively more efficient speed. Productivity at this speed is such that rather small decreases in fuel consumption result in significant decreases in operating costs, and these decreases are relatively larger than those which will occur at the Mach 2.5 speed. For example, a 3% decrease in fuel consumption at Mach 3 at a design range of 3,000 naut. mi. results in a 9% increase in productivity. For the same case at a speed of Mach 2.5, a 3% reduction in fuel consumption results in only a 6% increase in productivity. Operating costs for the two cases will be affected correspondingly. Planning Research Corp. concludes that any specific aircraft program should consider the Mach 3 regime area as well as Mach 2.5 in order to take advantage of the superior growth potential of the faster speeds.

A comparison of selected direct operating costs per available ton mile shows that the supersonic transport remains competitive with subsonic cargo jets until ranges of over 5,500 naut. mi. are considered. The report points out that the cargo jet used to illustrate cost factors is a second generation development, or swing-tail model, of present subsonic turbine transports while the supersonic transport reflects the performance of a first generation aircraft.

Even when total direct operating costs per available ton mile are considered, which include factors for depreciation and attrition, the supersonic transport again shows clear superiority. Depreciation costs represent the amortization of initial costs over a 10-year period and are based on procurement quantities of 100 aircraft. Commercial version of a supersonic transport also appears to be economically feasible. Conclusions drawn by Planning Research Corp. are:

- **Productivity** of a supersonic transport is superior to that of a subsonic turbine-powered transport and the margin of superiority extends even further over reciprocating engine aircraft.
- **Fuel costs,** as in the military version, will represent over half the direct operating cost of a supersonic transport. Related to productivity, however, cost of fuel per seat mile is the same for a 175,000 lb. Mach 2.5 supersonic transport as for the subsonic turbojet.
- **Heavier gross weight** supersonic aircraft will be less economical in commercial operation than the lighter aircraft because it appears that aircraft capability cannot be uniformly translated into passenger payload.
- **Mach 2.5 transports** appear to be the most economical. However, growth potential of a Mach 3 configuration makes the speed worthy of consideration.

From the standpoint of direct operating costs, the Mach 2.5 supersonic transport, weighing 175,000 to 300,000 lb. is more economical than the subsonic turbojet. On a set mile basis, fuel costs are equal but in other categories of direct cost the supersonic transport is 35 to 50% less expensive due to its superior productivity.

Indirect costs, which represent approximately 50% of total operating cost in commercial airlines, were analyzed by Planning Research Corp. to determine the historical trends in each of the indirect cost categories (passenger service, general and administrative, advertising and publicity, and ground equipment depreciation). Trends are projected for the supersonic transports and the values combined with direct costs in order to estimate total costs.

When indirect costs are added to direct costs, configurations up to 300,000 lb. at Mach 3, as well as Mach 2.5, are found to be less expensive and superior to recent turbojet aircraft at an operating range of 2,875 stat. mi.

Seat mile costs are also projected as they vary with range and selected seating capacity. Seating capacities of the supersonic transport were established at a design range of 4,025 stat. mi. If a shorter design range is desired, seating capacity should be increased with a resulting decrease in seat mile cost.

Greater efficiency of the supersonic transports is again evident by the fact that for a design range of 4,025 stat. mi., a Mach 2.5, 100-passenger transport could operate for a total cost of 2.05 cents per seat mile, whereas present day turbojet transport operating cost is about 2.65 cents per seat mile.

Projections of the air travel passenger market also are made to determine, within reasonable limits, the commercial market which might be served by supersonic transports in 1960-1975. Prediction of total air travel is made as well as of possible first class air travel in two major parts: domestically, within the borders of the continental U. S. and internationally, both between the U. S. and foreign or overseas countries and among the foreign countries themselves.

Long haul portion of total air travel volume indicates similar relative trends among the three categories of air travel. It is this segment of the market in which supersonic transports will operate. The Planning Research Corp. study indicates the growth of total long haul traffic to be from 31.6 billion passenger miles in 1960 to 116.7 billion passenger miles in 1975.

Investigation of the distribution of long haul air travel by minimum trip length revealed that, as the minimum trip distance is shortened, there is a resultant substantial increase in volume. The minimum trip parameter shows that 40% of the total passenger volume is attributed to trips of over 2,000 mi., but 60% to trips between 1,000 and 2,000 mi.

Competitive Transportation

Thus, the study concludes that supersonic transports can be competitive at the shorter ranges (1,000-2,000 mi.) where the bulk of the long haul volume is located. Requirements for commercial supersonic transports are adjudged to be approximately 60% of the total market in light of the historical fact that, as of any particular time, the fastest and most modern aircraft types have accounted for only about 60% of the commercial traffic carried or seat miles offered the public. Determination of aircraft requirements is based upon an aircraft utilization of 8 hr. per day, a passenger load factor of 60%, and the capture of 60% of the total market by supersonic equipment. Forecast made by Planning Research Corp. indicate an approximate 50% increase in the number of aircraft required in 1970 as against 1965 and an additional 40% increase by 1975.

A summary of Planning Research Corp.'s study can be obtained from the company's Economics Division for $2.50. Address is: 1333 Westwood Blvd., Los Angeles, Calif.

American Shuffles Management, Appoints Sadler General Manager

By L. L. Doty

Washington—American Airlines last week announced sweeping changes in its top-level management group which place G. Marion Sadler, a sales executive, in the newly created position of vice president and general manager.

With eight department heads, including three new vice presidents, reporting directly to Sadler, the former vice president-sales and service assumes full direction of the administration of the company's business under C. R. Smith who remains president of the airline. Five senior officers, who will concentrate on long-range planning programs, also will report directly to Smith.

The announcement of the changes came several days after the surprise resignation of Charles A. Rheinstrom, executive vice president of sales, who has rejoined J. Walter Thompson Co., New York advertising firm, which he left one and one-half years ago to return to American. Before joining J. Walter Thompson for the first time, Rheinstrom had operated his own consulting agency. Before that, he had been with American for 18 years.

Rheinstrom's resignation reportedly was the result of a strong disagreement with the revised organizational structure. Looked upon in aviation circles during the past year as the "number two man" in the company and "heir apparent" to the presidency, Rheinstrom sought and usually won complete freedom of action in the direction of his department.

This was evident when, shortly after rejoining American, he took a strong stand against the no-show penalty plan which American, including C. R. Smith, and the rest of the trunkline industry unanimously endorsed as a means of reducing no-show costs. Rheinstrom persuaded American to switch its position on the issue, and the plan was eventually killed since it lacked the unanimous backing needed to adopt such resolutions within the framework of the Air Traffic Conference.

Five vice presidents now reporting directly to C. R. Smith under the revamped management structure are William M. Hogan, executive vice president, finance and planning; O. M. Mosier, executive vice president, industry planning; George A. Spater, executive vice president and general counsel; C. W. Jacob, senior vice president, public affairs; and Willis Player, vice president, public relations.

In announcing the plan, C. R. Smith said that the senior members of management will now be able to concentrate on long-range planning and, at the same time, their experience will be available to the younger officers who are charged with the day-to-day conduct of the business. Associates close to Rheinstrom expressed the view that this role of "elder statesman" rather than that of an active director of daily activities would have little appeal to him. When he rejoined the company in April, 1958, Rheinstrom was named one of four executive vice presidents in the senior officer group of the airline. The others were Hogan, Mosier and Spater.

Sadler will direct the administration and operation of the carrier as vice president and general manager. Reporting to him will be three new vice presidents—R. L. Fitzpatrick, sales and service, F. J. Mullim, field activities, and Melvin A. Brenner, schedules and equipment utilization.

Other department heads reporting to Sadler are L. E. Glasgow, vice president and controller; P. W. Kayser, vice president, personnel; W. B. Whitacre, vice president, flight; F. C. Wiser, vice president, technical services, and W. G. Whitney, assistant vice president, organizational planning.

Thus, American places an increased emphasis on its sales activities as the growing number of jet transports threaten to boost seat capacity and reduce load factors. Since joining American in 1941 as a ticket agent in Nashville, Sadler has specialized in traffic and sales.

In 1955, while serving as district sales manager in Buffalo, N. Y., Sadler wrote a sales manual that attracted the attention of management and won him a position in American's New York headquarters as director of airline passenger service. In 1957, he was elected vice president, customer service.

C. R. Smith said that one of the prime purposes of the reorganization is to make certain that the company is grooming a new management group composed of junior officers who carry authority and responsibility. He said the program is designed to help develop the "many excellent and capable" people in American for the management of tomorrow's business by giving them increased responsibility today.

He said the change in the management structure results from a continuing study to determine how the airline's general office management as well as the field organization can best be established to handle today's business and prepare for the future. He added:

"We are in a growing business, one in which the techniques continue to change. We should not remain static in the form of our organization, just as we cannot afford to remain static in the kind of airplanes we operate."

City Opposes Third Hawaii Carrier

San Francisco—Hawaii's ambitions to develop its tourist potential competed with San Francisco's refusal to support additional air service between it and Hawaii at second phase hearings held here last week by the Civil Aeronautics Board on the Transpacific Route Case.

Spokesmen for the city say the decision to take the present stand was based on the fact that traffic does not justify authorization of a third carrier on the route between San Francisco and Honolulu. Present annual traffic volume is set at 100,000 passengers. The route is now flown by Pan American and United Air Lines. The spokesman said if traffic should grow to 150,000 passengers per year, a third carrier would be justified. United said the line plans to increase San Francisco-Honolulu seats 39% by 1962.

San Francisco is supporting authorization of unrestricted, competitive service from here to Tokyo via the great circle route and authorization of American carriers to operate into the South Pacific via Tahiti, a route already being flown by foreign flag carriers.

Western Air Lines President Terrell C. Drinkwater pointed out that the large number of carriers proposing routes from midwestern cities, bypassing San Francisco, is a possible explanation on the city's stand. San Francisco boosters have long identified the city as the "Gateway to the Orient."

Continental Air Lines says it is prepared to offer an economy class fare of $88 from San Francisco to Honolulu and $141 from Chicago. Western would propose a single fare to any point in the islands, with the privilege of landing at any point and continuing to another at a later date with no additional charge.

Hawaiian Airlines witnesses testified that expanded air service is essential to the continued growth of the island economy. Tourism was described as the only industry with any remaining potential.

San Francisco phase of the hearings, being conducted by CAB Examiner William J. Madden, is expected to last for two weeks. Washington phase, at which airlines will present arguments on their own behalf, will begin Dec. 1.

CHR LS-53 SEALS ARE FUEL RESISTANT AND FUNCTIONAL AT −65°F TO 400°F

The unretouched photograph to the right illustrates the effect of MIL-F-5624C fuel, hydraulic fluid and engine oil on a CHR LS-53 seal and an organic rubber seal.
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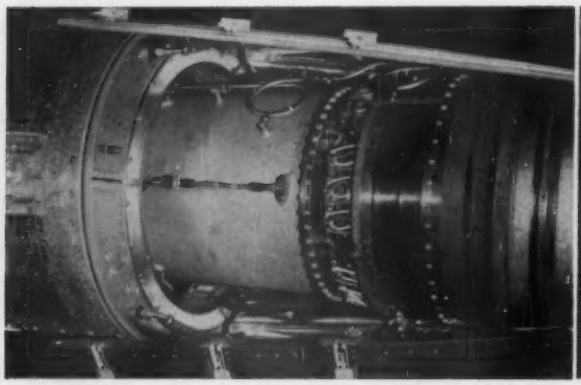
TESTS PROVE CHR LS-53 SEALS UNAFFECTED BY EXPOSURE TO FUEL, HYDRAULIC FLUIDS AND ENGINE OIL AFTER 70 HOURS AT 300°F.
ORGANIC RUBBER SEAL BADLY DETERIORATED BY EXPOSURE TO MIL-F-5624C AMEND 1 FUEL, HYDRAULIC FLUIDS AND ENGINE OIL AFTER 70 HOURS AT 300°F.



Shown is a CHR LS-53 seal installation on the bulkhead and clam shell doors of the C-130 B engine. This seal gets soaked in hydraulic fluids and oils. CHR's LS-53 seal meets service requirements.

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IATA Will Ban Manufacturers From 1960 General Meeting

Washington—Transport manufacturers of five nations have been banned from the 1960 annual general meeting of the International Air Transport Assn. in Copenhagen by the association's executive committee.

This action taken by the IATA executive committee at the recent annual meeting in Tokyo (AW Oct. 26, p. 49) was revealed in a letter from Sir William Hildred, IATA director general, to the U. S. Aerospace Industries Assn., the Society of British Aircraft Constructors and French, Dutch and Canadian manufacturers who had representatives at the Tokyo meeting.

Relations between IATA and the manufacturers during the annual meeting have been a source of friction for the past five years. Sir William's letter made it clear that IATA was not objecting to the formal entertainment program offered by the manufacturers during the annual meeting but to the constant contacting of airline officials by manufacturers during the intervals between IATA business sessions. Consequently, the manufacturers were being asked not to come to Copenhagen during the annual meeting there next September.

Sir William noted that he had originally warned the manufacturers in 1957 that their entertainment programs were interfering with the objectives of the annual meeting and that subsequently the manufacturers had cooperated in this regard at the New Delhi and Tokyo meetings by combining in a single function coordinated with the IATA program.

"My letter of 6th December, 1957, did not raise the question of the presence of manufacturers at the place of meeting," Sir William wrote AIA and SBAC. "I hoped and believed that the presence of manufacturers would give rise to no difficulty as long as there was cooperation on the provision of entertainment because, clearly, contact between the airline people and the manufacturers at appropriate times is necessary.

"Unfortunately we must recognize that these hopes have not materialized. In Toyko the activities of certain manufacturers gave rise to considerable adverse comment. Airline presidents found they could not venture into the hotel lobby without being accosted by manufacturers' representatives. When they wished to speak amongst themselves they found they could not do so, and they questioned whether the annual general meeting was the appropriate time for contact with manufacturers. Additionally, considerable difficulty was caused by strong pressure from the manufacturers for increased invitations to programed functions.

"The IATA executive committee considered this situation at one of its sessions in Tokyo during the annual general meeting and came to the unavoidable conclusion that the presence of the manufacturers' representatives was detrimental to the practical objectives of the annual general meeting and made difficult private conversations between airlines, created unhappy feelings and cost the manufacturers a great deal of money.

"So far as concerned the social program, they felt that the expected entertainment of a large number of manufacturers' representatives was an unwarranted addition to the host's expenses, which were already heavy enough. Obviously IATA cannot decide whether or not manufacturers will have representatives in the same city at the same time as the annual general meeting.

"However the executive committee came to the conclusion that it would be in the best interest of both the manufacturers and the IATA members if the manufacturers were to decide not to come. Committee members observed that they had not reached this conclusion without considerable soul searching and with some initial hesitation. However, they could not avoid the unmistakable conclusion that only on this basis would the annual general meeting achieve its practical objectives."

Some IATA members objected to the size of some manufacturers' delegations at the general meeting sites, some of which were four times the size of the largest airline group, and the manufacturers' pressure for quantities of invitations to social events. They also raised the point that the costs of the manufacturers' hospitality was actually increasing the sales costs of transports which eventually would be passed on to the airlines.

Some manufacturers feel the executive committee's decision has been influenced by a consistent antipathy of the IATA staff in Montreal to their activities. They point out that IATA was glad to have them finance entertainment at annual meetings where the host airline was under financial strain but, now that this problem has been solved, they feel IATA is trying to push them out of the picture.

Soviet Trade Unionists Rap French Aviation

Moscow—Soviet Russia's delegation of airline trade unionists which recently visited France to establish "friendly contacts" used the trip for Communist propaganda purposes upon its return to Russia.

Writing in Aeroflot's house organ, Grazhdanskaya Aviatsiya, V. Mishinkin, chairman of the Central Committee of the USSR's Aviation Workers' Trade Union, charged that French airline workers' living standards are constantly falling, that crews on Air France's piston-engine planes must fly up to 140 hr. monthly, and that French airline maintenance personnel live in fear of losing their jobs as a result of the Air Union pact providing for cooperation (and possible integration) among French, Italian, Belgian and West German carriers.

According to Mishinkin, "plans call for concentrating aircraft repair (for Air Union members) in West Germany. This can lead to reducing the (French) work force, to the transfer of skilled workers to other countries and to the firing of personnel who refuse to be transferred."

Braniff 707 Service Set for December

Dallas, Tex.—Braniff International Airways will inaugurate daily Boeing 707-227 "El Dorado Super Jet" service on Dec. 20, with the initial flight leaving New York for Dallas. First of four 707s ordered by Braniff will leave New York daily at 9 a.m. EST and arrive at Dallas 11:10 a.m. CST. It will then make a Dallas-Chicago flight leaving here at 12:15 p.m. and arriving at 2 p.m. and leave Chicago at 3:15 p.m. and arrive in Dallas at 5:05 p.m.

Following delivery of its first 707-227 next month, Braniff will get the remainder of its airplanes at one-per-month rate. The Mach .9 transport is powered by four 15,800-lb.-thrust Pratt & Whitney JT4A-3 turbojets providing approximately 5,800 lb. thrust more than the JT3 engines on earlier 707s. Extra thrust will eliminate need for water injection during takeoff, eliminating the heavy smoke dispersed by earlier model 707s.

Braniff has leased a Boeing 707 from the manufacturer for crew training at its Dallas base to offset the time delay in initial delivery occasioned by the crash of the airline's first airplane at the factory (AW Oct. 26, p. 45).

Braniff this year expects to go over the $74 million goal of revenues it set for 1959—in 1960 it is setting a quota some 25% higher, with a target of more than $100 million in revenues.

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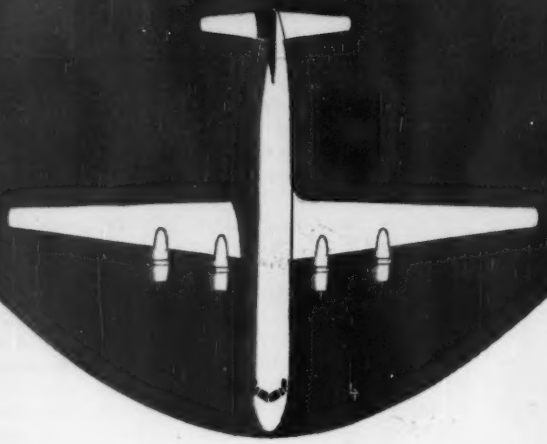

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Convair 880 Jet Transports Fill Production Stations

Convair 880 jet transports are being sent to field operations to be readied for airline delivery at the rate of one per month. Above, all six stations in Convair's final assembly building are occupied with 880s in various stages of construction. Company has boosted production of aft and forward fuselage sections to three per month as a step toward increased delivery rate—two a month in January, four a month in April and six a month starting in July. Convair 600 series moves into production next February.

Swissair Schedules DC-8, Caravelle Runs

Geneva—Swissair provisional jet schedules, slated to start next spring, are tied to May delivery dates for its first Douglas DC-8 and Sud Aviation Caravelle jet transports.

First DC-8 is scheduled to enter service May 4, in three-times-weekly flights on the North Atlantic between New York and Zurich. Second DC-8, to start service on June 10, will permit the airline to raise its frequency on the same route to seven times per week. Third DC-8, with an Aug. 1 service date, will be used to increase the frequency even further, working between nine and 12 total flights across the Atlantic with the three-plane fleet. Four of these flights will go via Lisbon.

Swissair's Caravelle flights will start on May 15. First Caravelle then coming into service will fly three times a week from Zurich to London. Flying time will be 1 hr. 35 min., thus cutting the time required by the Convair Metropolitan aircraft at present in service on this route by 30 min.

On July 1, Swissair's second and third Caravelles will start operations on the Middle East route. They will fly three times a week from Zurich to Tel Aviv, mostly via Geneva. Cairo, Istanbul and Ankara will be served twice weekly and there will be one flight a week to Beirut, Damascus and Teheran.

Fourth and last Caravelle to go into service with Swissair will start operations on Aug. 15 with a daily flight from Geneva-Rome-Geneva-London. On alternate days, the flight to Rome will go via Milan. The direct flight from Geneva to Rome will take 1 hr. 25 min. instead of 2 hr. 20 min., which is the flying time of the Convair Metropolitans serving Rome out of Geneva at present. This considerable difference in flying time on this route is accounted for by the time required for the Convairs to climb over the Alps en route to Rome.

CAB Notes F-27 Effect On West Coast Subsidy

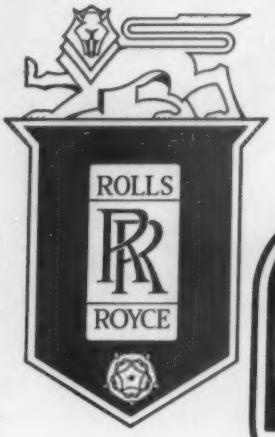
Washington—Effect of West Coast Airlines' Fairchild F-27 turboprop operations on the company's subsidy needs was raised by the Civil Aeronautics Board in an order proposing the grant of an additional $5 million in subsidy payments to the carrier for past and future needs.

Bulk of the increase in West Coast's temporary mail rates would cover $4.1 million for future operations over a one-year period dating from August of this year, with the remainder covering a past period from December, 1956, to August. Total sum voted by the Board in its show cause order is $400,000 less than that originally requested by the airline.

While agreeing that the carrier's subsidy needs have been increased by the introduction of F-27 service in 1958 and recent route awards, CAB noted that West Coast's request for $1.5 million more subsidy for the year ending Aug. 31, 1959, than that collected in the previous year coincided with the introduction of F-27 service.

Terming the coincidence a "cause of great concern," Board members added that "we do not yet have sufficient operating experience to determine whether the new equipment has been phased into the carrier's operations efficiently and economically. Pending such determination, we reaffirm our previous statements as to the heavy responsibility of management to guard against unduly burdening a carrier's subsidy requirements when converting to new equipment."

Additional subsidy asked for past periods by the airline was reduced, the Board said, as a safeguard against the possibility of an overpayment when final rates are established. West Coast's request for increased subsidy for the future one-year period was reduced to reflect the airline's suspension of service to Sun Valley-Hailey-Ketchum, Idaho, pending completion of adequate airport facilities.



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Financiers Urge New Local Service Plan

By Robert H. Cook

Indianapolis—Adoption of a new class mail rate subsidy formula for local service carriers was urged last week by financial spokesmen who cited the proposed Civil Aeronautics Board plan as the most promising means of attracting new expansion capital for the airlines (AW May 25, p. 41).

Reviewing the carriers' financial problems at a quarterly regional meeting of the Assn. of Local Transport Airlines here, top bank and investment house officials generally characterized the present subsidy payment formula as so "foggy" that investors hesitate to become involved with airlines unable to offer some concrete assurance of their expected earnings level.

Edward M. Blair, managing partner of William Blair Co., of Chicago, said that while the fast growth of the local service industry is superior to many larger industries and follows a pattern sought by investment bankers, the problem of placing loans and selling stock for the airlines is complicated by their poor earnings history and their subjection to stringent government regulations.

Growth Rate

Blair said the local service carriers have attained an annual growth rate of 22% based upon revenue passengers carried, as compared with annual cumulative internal growth rates of 24% for International Business Machines Corp. and 12 to 15% for Minnesota Mining & Mfg. Co.

He indicated, however, that this selling point has been of little aid to the carriers, most of which are still operating under the present complicated and changing temporary mail rates which are subject to constant revision.

A number of lenders and stockholders, Blair said, feel it wiser to wait until the airlines are placed upon definite final mail rates containing a predictable earnings level. Substitution of the CAB's class mail rate formula, essentially guaranteeing a definite subsidy payment for certain route segments and flight frequencies, would have the effect of setting a new earnings stability for the airlines, thus eliminating a feeling of "uncertainty" on the part of the lenders, Blair said.

Supporting this viewpoint, Robert R. C. Pape, vice president of the Chase Manhattan Bank of New York, told ALTA members that it is "about time local service airlines should be allowed to run their own business." Stock offerings by the carriers this year are the lowest since 1953 and are threatening the availability of both term and mortgage lending, he said. Adoption of the class rate formula, Pape said, would be regarded by banking circles as an advance knowledge of a definite return on which equity financing could be sold to improve carrier debt/equity ratios in line with lender desires calling for a more balanced ratio than generally maintained by the airlines.

Agreeing with this, Blair also warned the airlines that unless they are able to attain a more balanced debt/equity ratio, they may be unable to obtain funds for future re-equipment programs such as VTOL aircraft.

Harold R. Harris, president of Aviation Financial Services, of New York, concurred in the need for the class rate plan as a means of clearing away the "foggy atmosphere" surrounding the present mail rate subsidy formula. For investment purposes, Harris said the carriers would then be able to show that any new routes undertaken by them would not be operated at a loss.

In the meantime Harris said local service airlines unable to attract new equity capital may acquire new flight equipment through either the Guaranteed Loan Act or the equipment trust legislation which has the effect of making loans supported by aircraft collateral more attractive to financial sources.

Aircraft purchased under the latter legislation, he said, would be acquired under a type of "time payment plan." CAB spokesmen, he added, have indicated that planes purchased in this way will be recognized as an airline investment for all subsidy and rate making purposes, with the equipment regarded as being owned by the carrier from the inception of the transaction.

Long-Term Lease

As another alternative, Harris suggested that the airlines should explore the feasibility of long-term lease contracts, with or without options to purchase. While the CAB has not recognized straight leases of aircraft as an investment for subsidy and rate making purposes, Harris said that apparently no specific program of this sort has been presented to the Board. He urged that such action be taken by ALTA on the premise that CAB might approve this under a long-range view in many cases where neither the government guarantee nor the equipment trust treatment would be practical.

In actual practice, Harris said the equipment trust legislation would keep aircraft out of any bankruptcy proceeding, thus protecting the interest of the lender who would have first call on the carrier's assets and would thus regain his collateral. Most favored application of the trust certificates, he said, would be their outright sale to the public—a process difficult to carry out with the airlines because of the local service "never-never land" situation under the present subsidy system and the hopes for a class rate mail subsidy plan, which Harris said, might open the way for public financing through equipment trust certificates.

Local Service Financing

Blair and Pape both questioned the value of local service financing through the method of equipment trust certificates. Pape said the banks are satisfied with their customary chattel mortgage system of securing loans and would not be interested in equipment certificates, although insurance companies, which will lend beyond a seven-year repayment period, might be interested.

Blair pointed out that while such certificates have been held for up to 25 years for railroad rolling stock, the certificates sold usually covered boxcars which change little in value. Selling such certificates to cover dining cars, which may undergo many design changes, he pointed out, is far more difficult.

Use of trust certificates by the airlines would be little more than a stop gap measure, Blair said, and local service carriers ultimately will have to go to insurance companies for their debt financing because of airline depreciation schedules and reluctance of the banks to extend financing terms beyond a 10-year period.

Selling Stock

Questions by carrier representatives as to whether listing of local service stock on the New York Stock Exchange would help ease financing problems were answered by Blair, who noted that many trust companies refused to buy any stock not carried by the exchange. He cautioned, however, that the carriers would do better to remain in the over-the-counter market until they have a large number of stockholders. Listing on the exchange too early, without enough stockholders, tends to make the stock fluctuate to a point where it is

ALTA Survey

Indianapolis—Assn. of Local Transport Airlines has voted to authorize a detailed study of the public services rendered by its members. Work will be done by the Planning Research Corp., of Los Angeles, and is scheduled for completion in early 1960.

regarded as an "orphan" by investors, he said.

Pape advised another questioner to ignore any thoughts of a straight lease arrangement on airframes alone on the grounds that lenders are not interested in "airplanes without engines." Pape said such an arrangement, which is now being employed by American Airlines in leasing Allison turboprop engines for the Lockheed Electra, generally cannot be applied to local service carriers with limited financial resources.

ALTA also heard a report from Joseph P. Doyle, head of a Senate Interstate and Foreign Commerce Committee study group on transportation.

Doyle, in replying to a number of questions from the floor, indicated that the transportation group may greatly expand the scope of its work. Doyle told ALTA that there is now no definite deadline for completion of the study, but that the group will submit an interim report to the Senate on Jan. 31, the original date set for a full report. Current problem is that of collecting sufficient information, and Doyle asked the carriers to submit their problems in detail, along with ideas as to how to improve the industry and the reasoning behind them.

Citing a need for better coordination between all facets of transportation, Doyle said his group hopes to make recommendations, which will probably require congressional hearings, on the need to eliminate duplication and waste in the entire transportation industry. Some quarters, he said, have expressed a fear that excessive government regulation is leading to nationalization of the over-all industry and the study group will aim at unifying federal transportation regulations in an effort to eliminate duplication and separate legislative from executive duties.

If any government procedures blocking an orderly transportation program are discovered, Doyle said the study group will recommend that they be "weeded out." As an example, he said that the 17-member group will explore the need for additional commuter transportation, the responsibility of federal and local agencies and whether federal acts are handicapping this segment of transportation.

Subsidy will be a "pertinent part" of the study, Doyle said, with the problems of service into smaller cities and railroads versus airline facilities getting thorough attention. The group does not expect to explore carrier complaints about Military Air Transport Service transport of commercial traffic, Doyle said, since it is not covered under the Senate group's authority, but it will investigate proposed "user charges" providing for a tax increase on aviation fuels.

Mail Program Stalled by Dispute

Washington—Plans for an early beginning of the program to expand the movement of first-class mail by air (AW Nov. 16, p. 41) received a setback last week when the Post Office Department and airlines failed to agree on accepting either temporary or interim final rates.

An attempt to reach an agreement that would permit the Post Office to begin immediately with the expanded program while final rates were being determined by a Civil Aeronautics Board rate proceeding was made at a prehearing conference before CAB hearing Examiner Ralph Wiser.

In the absence of a rate agreement, it is doubtful that the Post Office will offer, or that the airlines will accept, any more than the limited amount of first-class mail currently being moved between a few cities until the proceeding is finished and the final rates determined.

A decision probably cannot be reached until late next summer.

Wiser has set Dec. 15 as the deadline for an exchange of information requests; Jan. 5 as the date for exchange of direct exhibits, and Jan. 15 for exchange of rebuttal exhibits. Hearings will begin Jan. 25.

Biggest stumbling block to an agreement appears to be the Post Office Department's firm stand against accepting either a temporary rate subject to a retroactive adjustment or an interim final rate for a six-month period which would not be subject to retroactive adjustment.

Airline representatives appearing at the prehearing conference unanimously agreed to accept a temporary rate pending the outcome of the proceeding but were split over CAB's alternate proposal to set a six-month interim final rate.

The Post Office Department said flatly, however, that a temporary rate subject to retroactive adjustment is not acceptable because of the uncertainty as to the final cost of transporting first class mail by air during the period the final rates are being determined. The department said a decision to airlift this type mail cannot be made unless actual cost is known in advance of operational changes.

The Post Office Department also said that, under a six-month interim final rate, it would not plan to make use of the airlift on a regular basis. Nor would it accept a firm rate for the transportation of first class mail by air for any period of less than 18 months. Airlines did not agree to extend the period for that length of time, because they said that, in effect, it would set a final rate for a period longer than it would take to complete the case.

While a majority of the carriers' representatives said they would accept a six-month interim rate as proposed by the CAB in its show cause order (AW Oct. 16, p. 38), others voiced strong objections to parts of the order.

Biggest objection to the interim rate voiced by carriers was directed at the terminal charges which they said should be set the same as for handling of air mail. If terminal charges were set the same as for air mail, some of the objecting airlines indicated they would probably accept the line-haul rate of 50% discount as final rates for the six-month interim period.

As a result of the stalemate, any action taken by the CAB to establish either a temporary or an interim final rate pending outcome of the case probably would not have much effect in getting the expanded program under way.

The Board could issue another show cause order prescribing temporary rates subject to retroactive adjustment as preferred by airlines. However, even in the absence of objections, it would not force the Post Office Department to make greater use of the airlines in the transportation of first-class mail.

Such action could actually result in a reverse situation because current final rates would be superseded by temporary rates that are not acceptable to the Post Office.

There is a possibility a compromise may be worked out, airline representatives said, if the Post Office will consider softening its stand. One proposal suggested, and one which Post Office representatives agreed had some merit, is that the Board issue an order expanding the scope of its present order which initiated the current experimental program. Under the proposal, a greater volume of mail could be moved to a greater number of points at current rates until the proceeding is completed and new final rates are established.

BOAC Plans Slash In Cargo Rates

London—Subject to government approval, British Overseas Airways Corp. will slash North Atlantic cargo rates for a wide range of goods by as much as 40% in some cases from Apr. 1, 1960.

For shipments of 99 lb. and more, examples of new rates per kilo (2.2 lb.) for selected goods will be: 5 shillings (70 cents) for foodstuffs, shoes, magazines, agricultural machinery, computing machines; 5 shillings twopence (72 cents) for clothes and textiles.

SHORTLINES

► **Allegheny Airlines** reports that its traffic figures for the first 10 months of 1959 have surpassed those recorded during the full year of 1958. Passengers carried increased by 19.9% over the 1958 period to 489,728. Revenue passenger miles were 20.2% higher than those for last year at 83,482,509.

► **The Babb Co., Inc.**, has sold six Douglas DC-6 transports owned by Scandinavian Airlines System to Aeronaves de Mexico, S. A. The contract includes spare parts and pilot and ground crew training program, with deliveries scheduled to begin this month.

► **Chicago Helicopter Airways** has opened its line to handle major overhaul of Sikorsky S-58Cs at its Chicago maintenance base. First aircraft, with 3,000 hr. of airline service, is the first S-58C in airline service to be overhauled.

► **Eastern Air Lines** has filed a tariff with the Civil Aeronautics Board to reduce fares between Miami and San Juan, Puerto Rico, from $45.70 to $37.00 each way. The new fare, subject to Board approval, would begin on Dec. 11.

► **Federal Aviation Agency** has extended the deadline date for submission of requests for federal aid for the construction of airports for Fiscal 1961 from Nov. 30 to Dec. 15, 1959, with announcement of the Fiscal 1961 program set for the end of February.

► **FAA also plans** to test a British FM radio altimeter, the STR 30-31 manufactured by Standard Telephones & Cables, this winter for possible application to automatic all-weather landing systems. Initial tests will be made to determine the altimeter's accuracy at the critical altitudes of 200 ft. or less.

► **Northwest Airlines** plans to extend its Univac automatic reservations system to 11 cities in its system by January. The system, now used at Minneapolis/St. Paul and Chicago, will be expanded to Miami, Tampa/St. Petersburg, Atlanta, New York, Detroit, Milwaukee, Spokane, Portland and Seattle/Tacoma.

► **Military Air Transport Service** last week reported the issuance of new service orders amounting to $255,427.50 for the transport of Air Force and Army passengers. They are: Alaska Airlines, Inc., $13,311; Hawaiian Airlines, Ltd., $24,948; Overseas National Airways, Inc., $130,897.50; Slick Airways, Inc., $43,380; Transocean Air Lines, $42,891.

AIRLINE OBSERVER

► United Air Lines is currently evaluating Sud Aviation's Caravelle turbojet transport for use over medium-range routes. Ten United technicians are at Toulouse, where the Caravelle is built, studying the aircraft in relation to United's routes. Chances are strong that United may purchase a fleet of the aircraft if satisfactory delivery dates can be assured and certain modifications are made by Sud. In addition, United probably will equip the planes—if the purchase is made—with General Electric's aft turbofan engines rather than the Rolls-Royce Avons with which the Caravelle is normally powered.

► **Watch for an early move by Braniff Airways to convert five Convair 440s to Allison turboprop power using the 501-D13 engine (AW Oct. 12, p. 37).**

► Price-cut war on South Atlantic routes between South America and Europe has forced a special meeting of the International Air Transport Assn. beginning today in Paris. With nine airlines now serving the South Atlantic route, seat capacity has been inflated far beyond traffic potential, depressing load factors drastically below break-even points. To meet the challenge, some carriers have dropped fares 40-50% below standard rates. Meeting was prompted by Argentina's complaint against this practice. If agreement is reached at the special session, mail voting system within the traffic conference will be used to establish new standard fares on the route.

► **Aeroflot, Soviet state-owned airline, reports that Tu-104 jet transports are carrying 48,000 passengers monthly on the Moscow-Leningrad route alone. Since start of the commuter-type jet services between Russia's two largest cities last April, total air traffic on the route has climbed over 1,000%.**

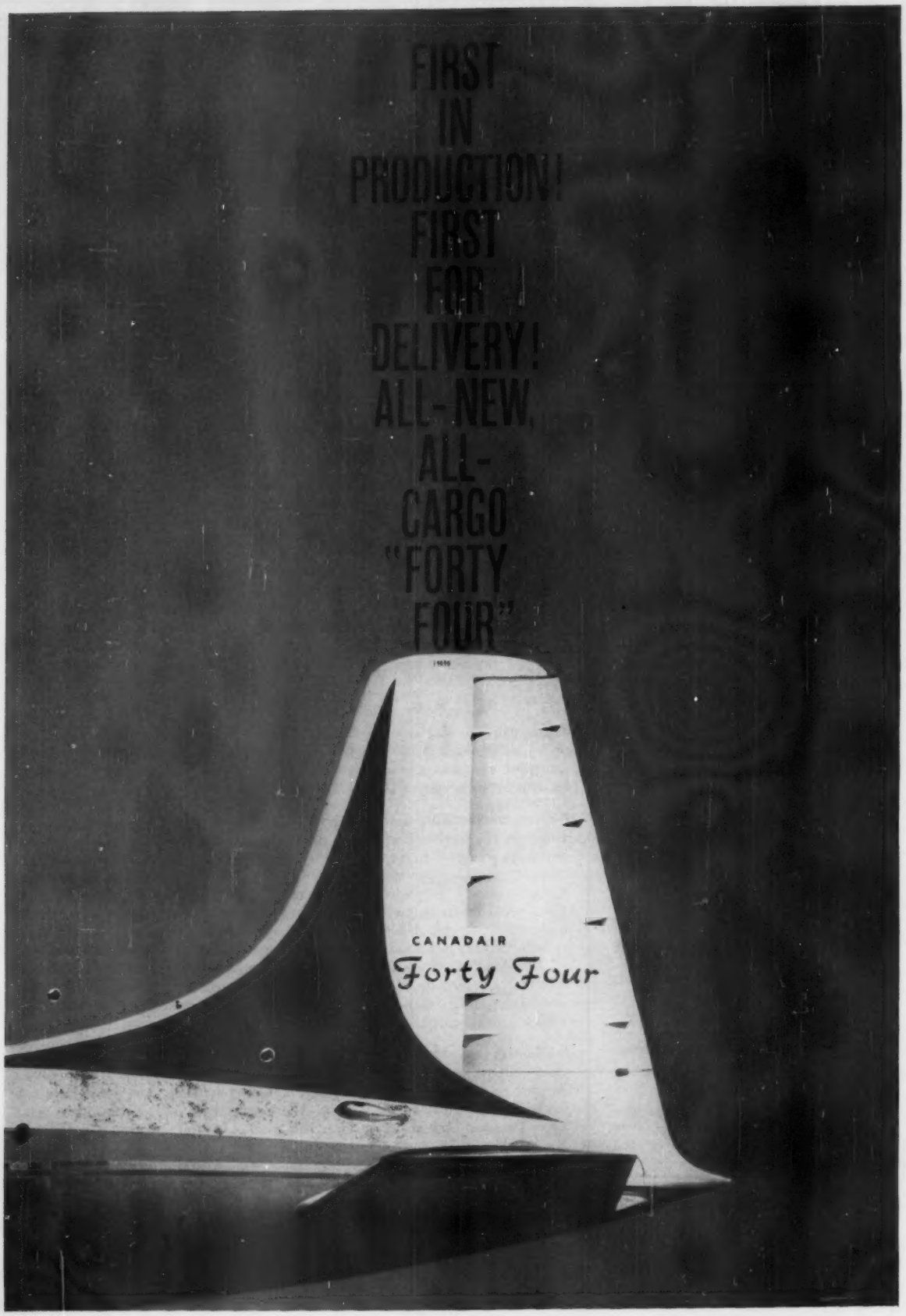
► Moves by domestic trunklines to work out an arrangement with the Defense Department for the use of seven Air Force and Navy airports for the training of pilots on turbojet transports will fail. Defense Department has told the carriers that the seven airports requested are not satisfactory for joint use because of high density traffic and proposed five alternate bases which could be used for civil training. The alternatives will be rejected by the carriers.

► **Iraq will join and support Saudi Arabia and Lebanon in the organization of a United Arab Airline, which has been proposed as an international air transport company capitalized with an initial $48 million as a commercial air arm for members of the Arab League (AW Nov. 9, p. 54).**

► Domestic trunkline traffic volume continued its upward trend in October, although the increases fell short of the spectacular jump in revenue passenger miles recorded in September. In addition, a sharp rise in available seat miles during October—due primarily to the steady introduction of more jet services—forced the industry's average load factor down to 59%, the first time it has fallen below the 60% level since February. Individually, trunklines operating jets began to experience gradual declines in jet load factors as competition increased. Revenue passenger miles during October reached 27.1 billion, a 13% increase over the same month of last year. In September, revenue passenger miles showed a 19% increase—the largest monthly increase since July, 1957. Available seat miles for October were up 15% compared with a 9% increase in September.

► **Chances are strong that airlines now operating from Detroit's Willow Run Airport will decide to transfer to the newer Detroit Metropolitan Airport to settle a local conflict here that began when American—later followed by Northwest, Delta and Allegheny—made the switch two years ago. Decision will be made later this week. Incoming airlines would face the private expense of about $8 million for the construction of hangars and $2.5 million for fuel storage facilities. Airlines now contemplating transfer are studying plans proposed by Wayne County for a $15.3 million expansion program for Metropolitan.**

► Sabena Belgian World Airlines has taken out a $20 million credit toward the purchase of five Boeing 707 turbojet transports with the Export-Import Bank and seven U. S. commercial banks.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First photographs of the Canadair Forty Four, taken September 30, 1959 in Montreal. The "Forty Four" is now on the line for Seaboard and Western Airlines Inc., The Flying Tiger Lines and the Royal Canadian Air Force.

CANADAIR LIMITED, MONTREAL, CANADIAN SUBSIDIARY OF
GENERAL DYNAMICS CORPORATION

Airline Income & Expenses—3rd Quarter, 1959

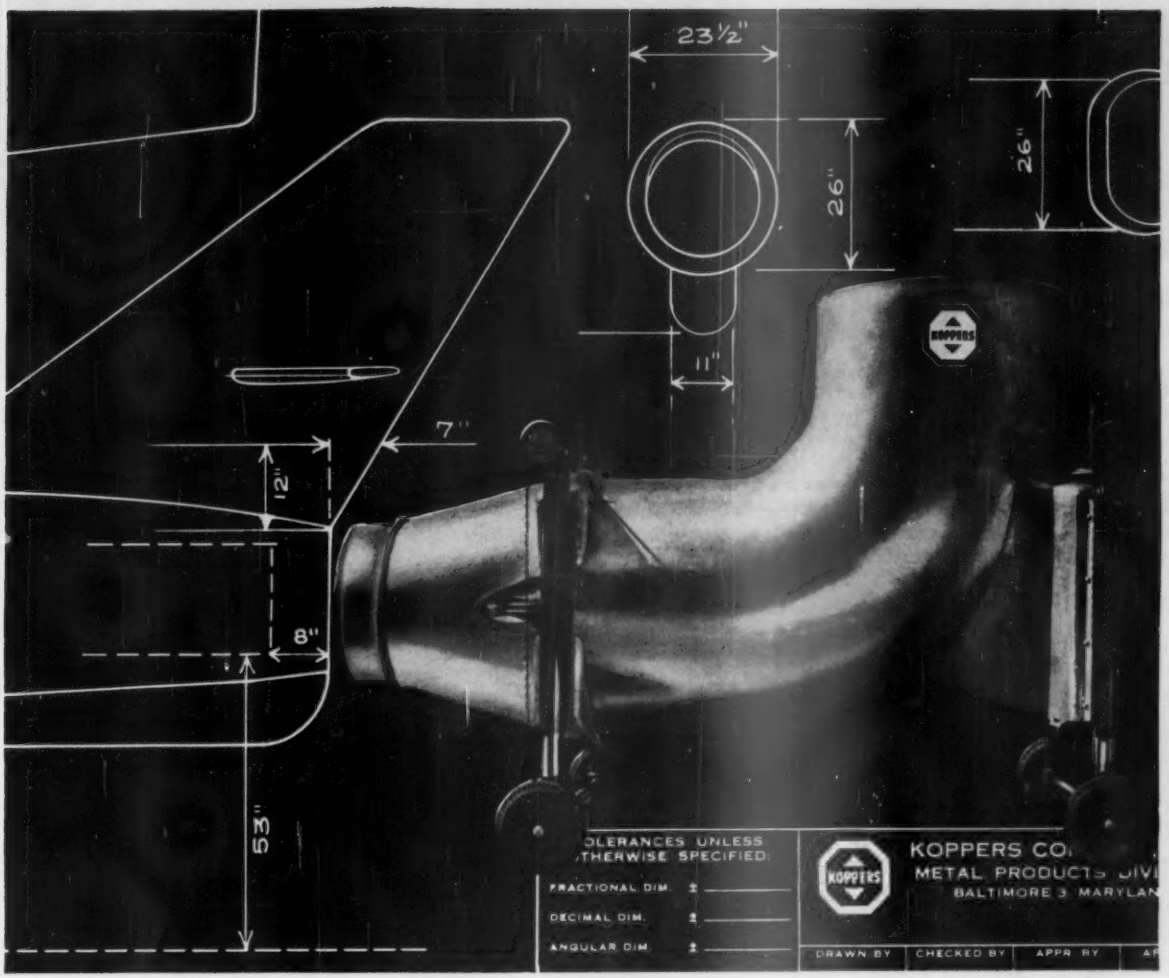
(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Property	Charter	Federal Subsidy	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	95,084,673	1,872,035	7,997,528	173,381	.....	105,430,723	90,959,692	14,608,252
Braniff	14,659,997	404,107	925,996	92,195	.....	16,171,529	15,427,981	556,821
Capitol	25,480,317	560,231	1,013,536	25,409	.....	27,343,107	26,933,918	—186,192
Continental	13,440,291	165,485	436,815	119,880	.....	14,306,988	12,419,182	1,467,836
Delta	22,295,196	489,314	1,613,807	65,821	.....	24,643,813	23,868,117	814,366
Eastern	64,963,844	1,136,954	2,662,436	128,787	.....	69,267,540	69,034,823	—496,577
National	12,174,854	241,574	766,155	227,465	.....	13,508,887	15,327,726	—1,903,899
Northeast	7,842,916	101,628	295,971	1,382	.....	8,296,514	9,508,564	—1,572,179
Northwest	21,369,458	549,585	1,648,400	24,877	.....	23,750,414	20,698,077	3,457,082
Trans World	72,315,922	1,354,613	3,401,390	323,325	.....	77,736,079	65,496,703	12,612,500
United	74,522,986	2,369,993	6,510,096	953,614	.....	85,816,168	74,577,343	11,738,829
Western	15,885,931	292,542	518,488	34,232	.....	16,831,082	12,777,964	4,038,653
INTERNATIONAL								
American	1,529,836	10,829	165,455	.....	.....	1,780,699	1,677,253	103,842
Braniff	1,918,990	40,258	205,065	.....	.....	2,216,385	2,110,086	81,563
Caribbean-Atlantic	723,042	6,995	28,963	43,342	.....	811,174	639,403	171,876
Delta	1,348,670	13,035	78,264	.....	.....	1,444,179	1,381,390	57,218
Eastern	7,160,001	67,739	269,936	538,167	.....	8,040,685	6,457,899	1,497,080
Mackey	454,210	.....	10,349	4,935	.....	474,104	420,384	53,776
National	950,546	11,502	68,378	.....	.....	1,030,150	993,432	36,718
Northwest	7,799,623	1,656,265	1,368,533	83,547	.....	11,149,711	9,140,776	1,981,699
Pan American Combined	83,582,239	4,388,629	11,178,801	3,196,479	.....	104,115,919	92,192,143	11,304,808
Alaska	1,222,566	46,697	132,176	862	.....	1,397,842	1,469,944	—71,651
Atlantic	42,619,844	2,039,185	4,067,352	706,019	.....	50,086,556	40,154,080	9,831,418
Latin America	21,545,406	578,589	4,176,167	504,787	.....	27,128,628	27,570,224	—363,224
Pacific	18,194,423	1,724,158	2,803,106	1,984,811	.....	25,502,893	22,984,649	2,556,408
Panagra*	.....	.....	.....	.....	.....	.....	.....	.....
Resort	.....	.....	.....	629,411	.....	672,012	815,322	—138,114
Trans Caribbean	314,407	.....	74,070	.....	.....	445,914	490,800	—66,371
Trans World	19,189,765	1,316,250	1,160,859	4,027,736	.....	26,396,527	24,547,845	1,767,769
United	5,461,451	146,198	81,527	.....	.....	5,732,068	4,018,691	1,687,906
Western	1,159,655	12,838	26,095	.....	.....	1,214,476	1,016,785	181,256
LOCAL SERVICES								
Allegheny	2,226,945	25,911	113,670	7,534	613,590	2,995,814	3,153,138	—186,318
Bonanza	951,323	8,443	35,599	37,191	437,759	1,474,179	1,643,683	—213,527
Central	614,106	22,200	34,144	18,042	693,498	1,391,023	1,352,314	33,659
Frontier	1,630,171	39,180	131,998	33,954	2,085,203	3,946,634	3,445,234	447,409
Lake Central	703,060	18,614	28,827	1,880	449,612	1,202,680	1,141,345	44,439
Mohawk	2,113,752	22,018	72,475	50,740	500,879	2,769,608	2,679,855	29,700
North Central	3,454,642	80,867	146,775	87,192	1,115,943	4,897,739	4,937,141	—96,486
Ozark	1,867,411	43,543	106,937	4,033	842,008	2,880,255	2,716,890	149,365
Pacific*	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont	2,021,187	30,104	70,313	65,573	1,122,711	3,348,960	3,040,618	239,260
Southern	771,980	22,885	46,663	11,521	594,459	1,454,365	1,535,791	—89,469
Trans-Texas	1,227,007	33,445	77,106	32,050	740,675	2,122,665	2,089,660	29,812
West Coast	1,327,387	16,997	39,675	5,449	418,077	1,819,451	2,322,049	—570,188
HAWAIIAN LINES								
Aloha	1,283,121	6,127	24,143	502	.....	1,333,445	1,110,840	188,947
Hawaiian	1,732,657	7,005	216,618	212,767	.....	2,209,769	2,183,210	—56,130
CARGO LINES								
AAXICO*	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana	.....	.....	310,253	39,229	.....	378,563	344,649	18,406
Flying Tiger	.....	30,881	4,016,807	4,317,967	.....	8,339,878	7,456,491	867,690
Riddle	.....	6,553	1,080,629	107,513	.....	1,209,798	1,421,437	—256,988
Seaboard & Western*	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	.....	2,865,757	.....	2,964,917	2,670,963	208,605
HELICOPTER LINES								
Chicago Helicopter	382,713	9,581	1,754	700	440,772	835,568	676,951	165,276
Los Angeles Airways	87,843	35,498	28,779	437	232,254	386,858	353,063	40,301
New York Airways	258,225	10,529	12,605	15,353	551,691	868,165	847,184	11,694
ALASKA LINES								
Alaska Airlines	850,764	153,919	183,044	750,268	397,692	2,338,126	2,274,517	24,255
Alaska Coastal	362,499	26,103	34,000	29,914	127,851	588,822	584,796	—3,622
Cordova	54,247	34,615	30,348	127,271	79,414	328,898	302,745	30,996
Ellis	227,059	15,521	25,437	17,404	81,532	378,143	392,599	—15,547
Northern Consolidated*	.....	.....	.....	.....	.....	.....	.....	.....
Pacific Northern	2,618,414	196,442	322,457	2,747	381,468	3,571,327	3,068,245	458,359
Reeve Aleutian	402,535	105,230	101,422	82,523	.....	720,832	556,570	304,230
Wien Alaska	558,153	148,367	129,536	424,505	132,922	1,470,474	1,429,701	—9,512

*** Not available.**

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

Northwest—Non divisional (nonoperating income $553,632—income before taxes $553,632—tax $298,400—net income $255,232).



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Hilton, IATA Members Dispute Credit System

Washington—Credit card battle between the airlines and independent credit card firms moved to the Civil Aeronautics Board as members of the International Air Transport Assn. and the Hilton Credit Corp. argued the relative merits of their credit system.

Hilton urged the Board to confirm an earlier CAB opinion (AW Oct. 26, p. 39) that IATA agreements prohibiting airline members from using any credit cards other than the Universal Air Travel Plan should be disapproved. Terming IATA a "monopolistic price fixing cartel," Hilton said the agreement places a financial burden on the public, denies carrier members a chance to select their own credit plans and amounts to a "joint industry boycott" of established credit card companies and a "naked and flagrant violation" of anti-trust laws.

Defending the agreement, 13 IATA members replied that selection of the UATP plan as the sole credit card for members was based upon unanimous adoption by the members with the individual concurrence of each carrier. The airlines contended that a major reason for not adopting an agreement that would permit use of several types of card plans, such as the Hilton Carte Blanche, was that agent's fees would be assessed the carriers. A uniform plan, IATA added, also would avert any possible traffic diversion between members seeking a competitive advantage through an expansion of credit programs.

Hilton told the Board that much of the public cannot afford the "exorbitant" $425 deposit required by the Universal Air Travel Plan system, which, it said, benefits the larger airlines but not the smaller members who need the resources of an established credit plan to expand their traffic base. CAB denial of the IATA agreement would free the individual airlines to make their choice of a credit card plan.

The credit company added that, while a carrier might object to working with any particular credit corporation, it cannot under existing anti-trust legislation "conspire or agree to boycott" to exclude competing plans.

Replying to the anti-trust charges, the airlines noted that one anti-trust principle is that "you can't give the big boys preferential treatment over the little boys." Card companies with "hundreds of thousands" of subscribers are "big boys" and could thus "drive a hard bargain" with the airlines, IATA members told CAB.

Pointing out that the airlines would have to bear much of the cost of any "outside" credit plan, the carriers doubt that plans such as Carte Blanche could generate more air travel.

"Airlines receive almost daily, from outsiders, schemes for running their business," the IATA members said, "and we view with skepticism proposals by those having substantial financial interests in them."

Uniformity of the UATP plan results in lower direct carrier costs to implement it, IATA said. Available to all airlines on the same terms, the plan requires a refundable deposit from the subscriber but does not contain extra administrative costs stemming from payment of agent's fees as required by other credit plans, the airlines contended.

American Shippers Inc. Lose Operating Rights

Washington — Civil Aeronautics Board has issued a technical cease and desist order against American Shippers, Inc., following the firm's conviction by a civil court which levied a $10,500 fine for 15 separate violations of sections of the Federal Aviation and Uniform Bill of Lading Acts.

The Board's action was in accordance with an offer by American Shippers that CAB compliance attorneys forward to the U.S. Attorney for the Southern District of New York information on the original CAB charges, and, in the event of a conviction and judgment against the company, issue a cease and desist order in lieu of earlier demands for revocation of American Shippers' operating authority. List submitted by the compliance attorneys covered 62 counts, on which the court found the company guilty of 15 counts with a fine of $700 on each.

Violations against American Shippers included charges that the firm:

- **Declared lower rates** to direct air carriers than the weights recorded in its own shipping documents and used as a basis for billing its own customers.
- **Misclassified commodities** on direct air carriers' air bills by declaring to the carriers a different description of the commodities involved than that described in its own shipping records and used it as a basis for billing its own customers.
- **Offered, charged for and** carried out assembly and distribution services not covered by its tariff provisions.
- **Charged rates different** than those specified in its tariffs covering pick-up and delivery service.
- **Transported shipments at rates** based on actual rates although higher rates were provided for in its tariff.
- **Offered and furnished free** teletype service not covered in its tariff filings.

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MOTOROLA MILITARY ELECTRONICS CAPABILITIES REPORT:

Strategic Deployment of Technical Personnel

Dr. Daniel E. Noble, Executive Vice President, Motorola, Inc.

"Dynamic organization...not static...is the key to productive use of technical talent in the field of military electronics."

(Advertisement)

The next two pages tell how Motorola has achieved "dynamic organization"...

William S. Wheeler, Vice President and General Manager
Military Electronics Division

Arthur Reese, Vice President and General Manager
Communications Division

Three field commanders direct day-to-day activities of Motorola's technical divisions. Wheeler's Military Electronics Division concentrates directly on military problems, drawing on the resources of Reese's Communications Division (world's largest producer of two-way communication systems) and Hogan's Semiconductor Division (world's largest producer of power transistors and leader in mesa transistor development and production). Behind this technical task force stands Motorola's strength in consumer electronics; in an emergency the company's total complex of 18 plants in four states can be converted to mass production of military equipment.

Dr. Lester Hogan, Manager
Semiconductor Products Division

Of Motorola's 2,000 engineers and scientists, four out of five work under the direction of Dr. Daniel E. Noble, Executive Vice President. One of the three divisions under his command is devoted exclusively to military electronics; two others provide strong support. Working together, they form a

MOBILE TECHNICAL TASK FORCE

Officials of the Air Force Flight Test Center at Edwards faced a particularly knotty problem. Specialized microwave equipment was required to relay telemetry from aircraft in remote areas.

At the request of the military, Motorola rapidly assembled the talent and equipment of its tri-divisional technical task force. Heaviest contributions to the project were made by Motorola's Military Electronics Division. But important help came from other sources: microwave equipment and vhf receivers from Motorola's Communications Division; specialized transistor circuitry from the Semiconductor Products Division.

With this swift concentration of technical talent drawn from a diversity of company sources, Motorola was able to solve a major problem for the Air Force in record time.

Few organizations serving the military today can so rapidly merge diverse technical talents and productive capacities as can Motorola. Its three "task force" divisions, under the single command of Dr. Daniel Noble, can be marshalled almost overnight for the solution of urgent military electronics problems. Cross-fertilization of ideas and techniques is the certain result.

The success of this flexible organizational structure was again demonstrated by Motorola's part in the development of the Project Mercury Space Capsule. The Capsule's command control receiver, developed by Motorola's Military Electronics Division, is the smallest all-transistorized radio receiver of its type available, thanks to mesa transistors developed by the Semiconductor Division and miniaturization techniques borrowed from packaging specialists of the Communications Division. In another instance, Motorola's Semiconductor Division developed the first samples of a new type of electronic facsimile paper with important military applications.

In an era marked by a chronic shortage of competent brain-power, Motorola's strategic deployment of its technical resources is an effective answer, both in the solution of current problems and in conducting long-range research.

Strategic deployment of manpower is only one of the reasons why Motorola is able to design, develop and produce military systems and equipment with speed, economy and reliability. Motorola's exclusive concentration in electronics, its cost-conscious approach to producibility, and its preoccupation with reliability, are evident in every Motorola military product, from the smallest solid state device to the most complex weapons systems.

For a comprehensive brochure on Motorola's Military Electronics capabilities, write: *Technical Data Service, Motorola, Inc., Military Electronics Division, 8201 East McDowell Road, Scottsdale, Arizona.*

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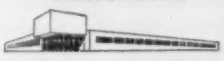

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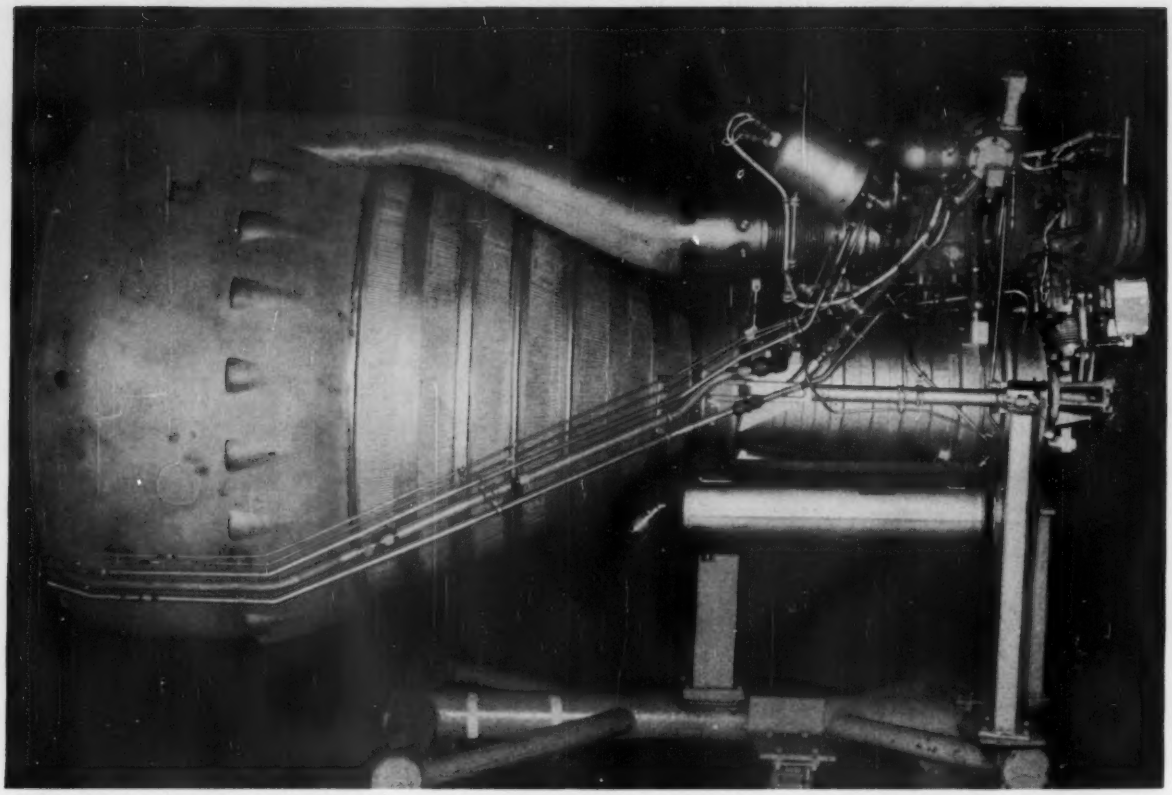


ASPIRATOR shroud around nozzle end of Atlas sustainer engine directs turbopump exhaust gases into main propulsive stream.

Rocketdyne Studies Pumps, Future Liquid

By Russell Hawkes

Canoga Park, Calif.—Greater simplicity, rapidly improving turbopumps and signs that better analytical techniques may soon reduce the expense of cut-and-try development are leading trends in liquid propellant rocketry noted at Rocketdyne Division of North American Aviation as second generation development gathers momentum.

Eight years after conception of the first family of U.S. large rockets, experts here are studying these trends and plotting the course of future development. Advances now being sought include:

- **Turbopumps** driven by gas tapped from the thrust chamber.
- **Satisfactory** uncooled nozzle skirts to ease handling and eliminate part of fuel pressure loss due to use of fuel for regenerative cooling.
- **Better thrust** vectoring devices, possibly including magnetohydrodynamic exhaust stream deflection or aerodynamic deflection by injecting secondary hot gas or liquids at different points in supersonic flow.
- **More easily producible** propellant injectors.
- **More useful storable** and high energy propellants.

Importance of these advances is expected to be on a par with earlier development of bootstrap turbopumps, axial tube-bundle chamber and nozzle walls, gimbaling thrust chambers and modern propellant injectors.

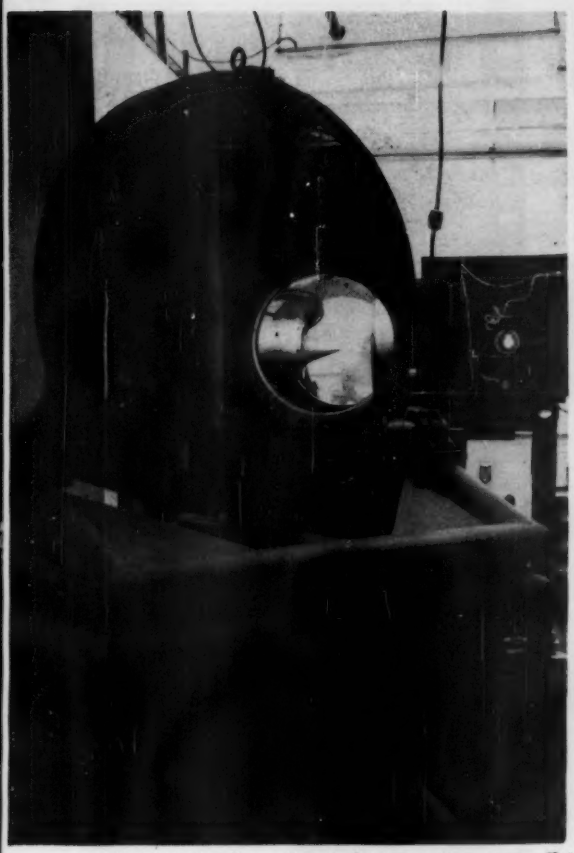
Exotic Devices

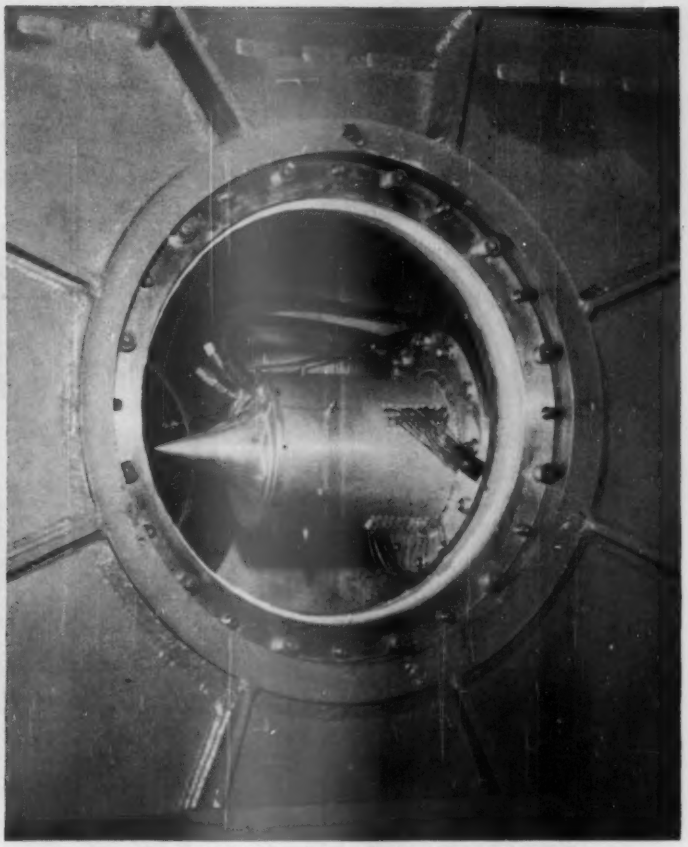
Still being evaluated at Rocketdyne are more exotic devices, such as the annular spike nozzle. It is an outgrowth of the plug nozzle long studied by rocket engineers. Supersonic flow from the annular chamber, or perhaps a ring of small chambers, converges upon the tapering spike whose curvature would duplicate and improve upon the effect of conventional bell-shaped expansion skirt. Spike nozzle rockets have been fired at Rocketdyne for brief periods. As yet unsolved is the problem of heat transfer to the thin, sharp point of the spike.

Also under study is the diabatic chamber, which looks like a conventional nozzle with the injector pushed back into the middle of the nozzle throat. In theory, elimination of the convergent part of the nozzle should be beneficial with extremely intense combustion such as that of hydrogen and fluorine. However, research on it has not been very productive, so far.

Other research is being directed toward design of magnetohydrodynamic nozzle throats or aerodynamic ones created by injecting gas or liquid into a cylindrical chamber near the desired location of the throat. One benefit of this scheme might be the ability to continuously adjust nozzle parameters to ideal values as environment changes during the course of a flight.

Certainly no less important than these attempts to make long forward steps in technology is steady improvement in the well-established propulsion systems used in Atlas (MA-2 and MA-3), Thor (MB-3), Jupiter (S3D) and Saturn (H-1). Also included in this list should be the big space boosters—E-1, of 400,000 lb. thrust (AW Nov. 9, p. 31) and National Aeronautics and Space Administration's F-1 (1.5 million pound





THRUST chamber spike nozzle, to create a more efficient expansion ratio, is tested (above) in a Rocketdyne wind tunnel.

Propellants

thrust) which by NASA specification is to use conservative, proven technology.

Perhaps the most lucrative efforts in continuing development of this family of rockets have been those directed toward propellant pump improvement. Some factors which turbopump engineers had to deal with were these:

- **If speeds of rotary pump** and gas turbine power units can be doubled, diameters can be halved and weights will be reduced by an even larger factor.
- **Pump speeds are limited** by danger of cavitation which causes sharp drop in flow rate, pressure and thrust if too much suction is developed at pump inlet.
- **Increasing tank pressurization** can increase safe operating speed of the pump but also rapidly increases tank weight because of increased strength needed.
- **Propellant pressure drop** through the injector face must be great enough to guarantee good combustion stability by preventing feedback of chamber pressure disturbances through the propellant lines and pumps.
- **Propellant pressure drop** through the injector face must be as small as pos-

EXCESS gases are ignited and piped off at Rocketdyne turbopump field test center.

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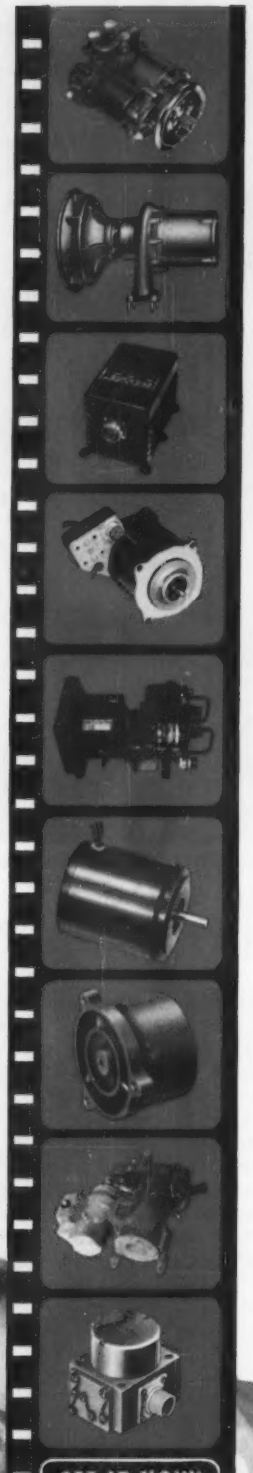

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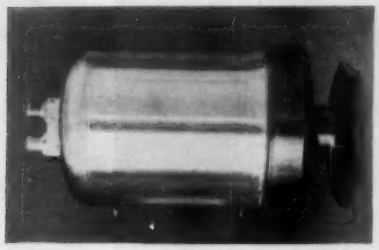

SOLID propellant turbine start spinner (size of half-gallon container) is in use on Atlas and Saturn (H-1) engines. Device replaces several valves and tanks.

sible to minimize pump size and power requirement.

• **Turbines operate** most efficiently at high temperatures, speeds and pressures, but materials are only now becoming available which can withstand turbine stress levels at temperatures produced by an efficient mixture ratio of rocket propellants.

• **Use of a cool rich fuel** mixture in the turbopump system in very large rockets causes a significant weight penalty.

The problem of linking a limited-speed pump to a high-speed turbine led Rocketdyne to replace single-shaft, direct-drive used in V-2 and Redstone with reduction gearing for intermediate and intercontinental range ballistic missile rockets. It is one of the most highly stressed gear trains ever designed. During the start sequence, the turbopump goes from dead stop to 30,000 rpm. in one-half second.

Direct-Drive Pumps

Rocketdyne now is returning to direct-drive turbopumps because of improved pump designs. Measure of how fast a rotary pump can turn safely is suction specific speed, which is defined as the speed which the pump can attain without cavitation. Mk. II pump used in early ballistic missiles had a suction specific speed of 10,000. Mk. III started at 12,000 and has now been pushed to 60,000. Pumps still in research phases have occasionally been pushed as high as 90,000. These improvements have been made largely by design of better inducers at pump inlet to impart velocity before propellant reaches impeller. Suction specific speed is dependent upon propellants being moved since it is inversely related to net positive suction head (inlet pressure minus vapor pressure of the propellant). Therefore, if a propellant with lower vapor pressure is used, it will cut suction specific speed of the pump. Company engineers say they have demonstrated the ability to pump any seriously considered propellant including liquid hydrogen.

Rocketdyne pumps have progressed from the Mk. I which developed 850 hp., weighed 300 lb. and pumped 1,300 gpm., to the largest current pump aimed

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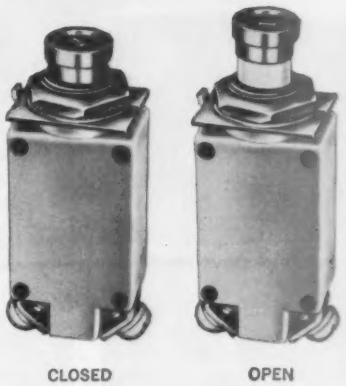

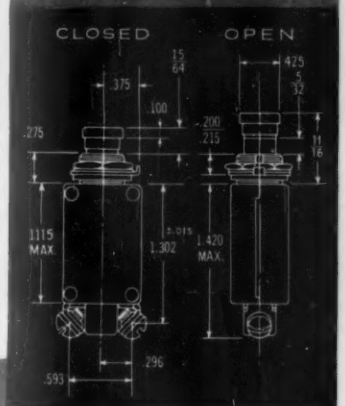

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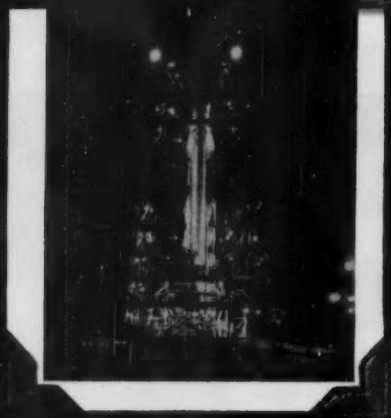

OFFICIAL U.S. A.F. PHOTO
of the Atlas lift-off
at Vandenberg, A.F.B.
on September 9, 1959.
This was the first official
firing by SAC crew to
test operational capability.

A memorable event in the Album of Space Technology

Many significant achievements will be added to those already recorded in the chronicles of military and scientific space technology. Many important milestones in the conquest of space will be passed. None, however, will surpass the realization of America's operational capability in Intercontinental Ballistic Missiles. The threshold of this phase of our national defense was passed on September 9, 1959, with the historic launch of an Atlas by a Strategic Air Command crew at Vandenberg Air Force Base, California. Measured by any standard no event could have been more timely... more rewarding.

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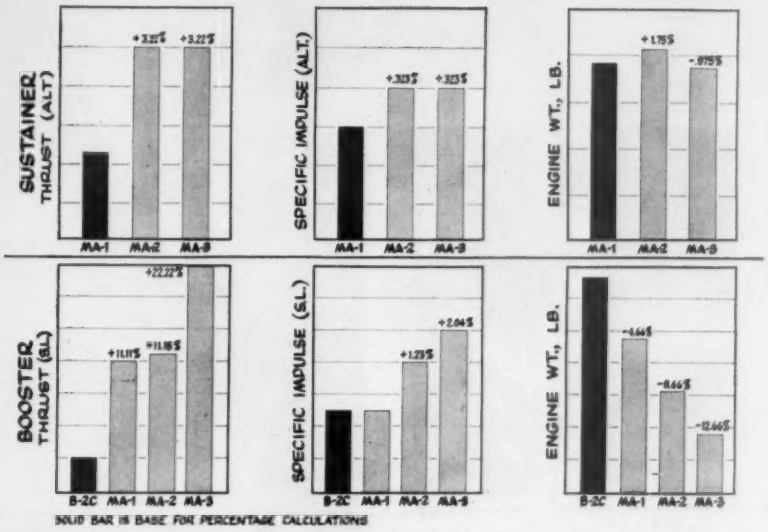

CHART DETAILS ATLAS engine performance and weight.

at a specific application developing well over 50,000 hp. and moving almost 28,000 gal. of propellant fluid per minute. It is only twice the size of the Mk. I, although its power output is greater by a factor of more than 60. This vast increase in pump power is required because flow rate must vary almost directly with thrust.

Efficiency Rises

Turbopump efficiency, the ratio of horsepower in the flow to input horsepower, has risen from around 60% in early rockets to about 85% for pumps in current and near-future boosters. Engineers at Rocketdyne report that a plateau has been reached in turbopump efficiency. They believe conventional approaches to improved efficiency are about exhausted.

In the past, upward trend in suction specific speed has been so marked that it has been good procedure to pressurize propellant tanks in new missile designs to a higher than desirable level making it possible to capitalize on later pump improvements. When better pumps come along, the missile maker can then cut the surplus strength and weight out of his tankage.

A problem now under study is that raised by the inadequacy of current lubricants in deep space because of the harsh environment. Rocketdyne engineers are considering use of propellants as lubricant for turbopumps and other rotating machinery, though most propellants have significant shortcomings in this application. Another deep space problem is design of high performance turbopumps which will remain absolutely reliable for years without attention. At least part of the solution will be to cut the number of components and beef up stressed parts to higher safety factors. Considering the size of projected vehicles, weight penalty for any beefup will probably be more than usually distasteful.

While turbopump performance is one of the most important keys to good combustion, the mechanism of combustion itself is still understood largely in qualitative rather than quantitative terms. Injector and chamber design consists of building and testing several configurations selected by experienced engineers on the basis of formulas which were successful in the past, plus well informed guesses on the influence of new factors such as better fuels. Combustion chambers must be made as short as possible to save weight, yet long enough to permit complete combustion of the propellants. Hotter, quicker combustion allows the chamber to be shortened, but hot combustion tends to be more unstable. If instability is solved, minimum chamber length is set by the danger of heat transfer into the injector face if combustion occurs too far forward.

Specific Impulse

Hot combustion combined with exhaust gases of low molecular weight produce high specific impulse. Rocketdyne engineers have learned that best propellant mixture ratio is that which produces a compromise between combustion temperature and low molecular weight of combustion products. With conventional RP-1 narrow-cut kerosene and liquid oxygen, the best mixture is somewhat fuel-rich. Amount of oxygen used is only large enough to consume about 70% of the fuel. This sacrifices part of the temperature which could be attained with stoichiometric mixture in order to increase the percentage of carbon monoxide and hydrogen in the exhaust and decrease the amount of heavier carbon dioxide and water mole-

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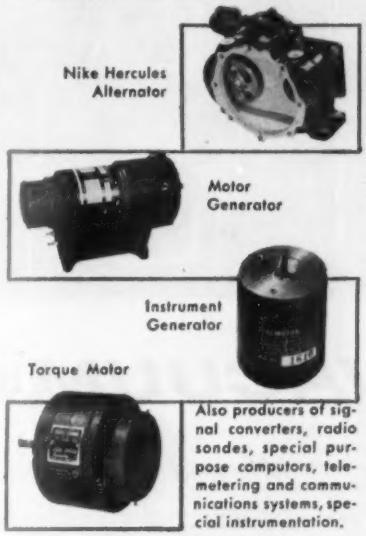

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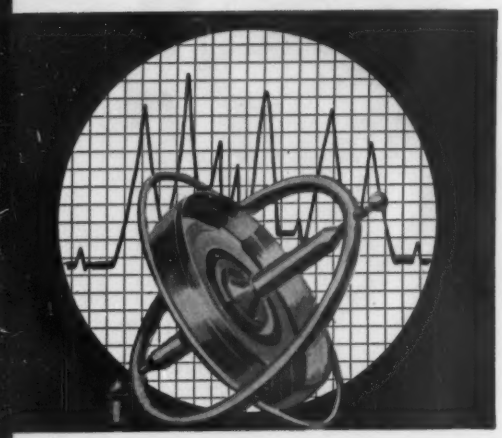

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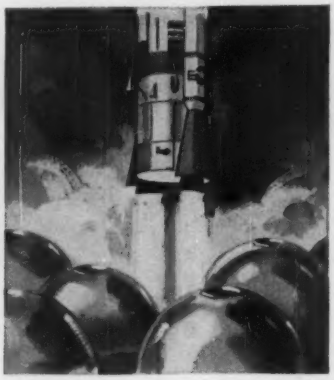

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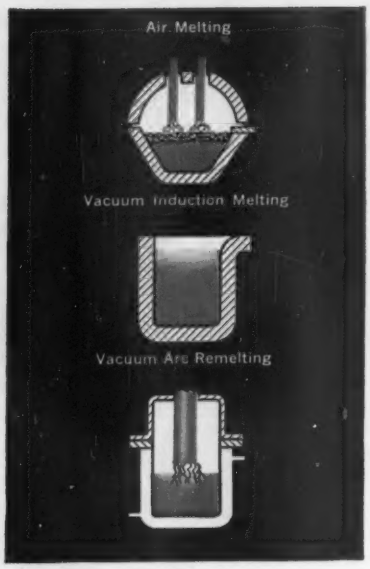

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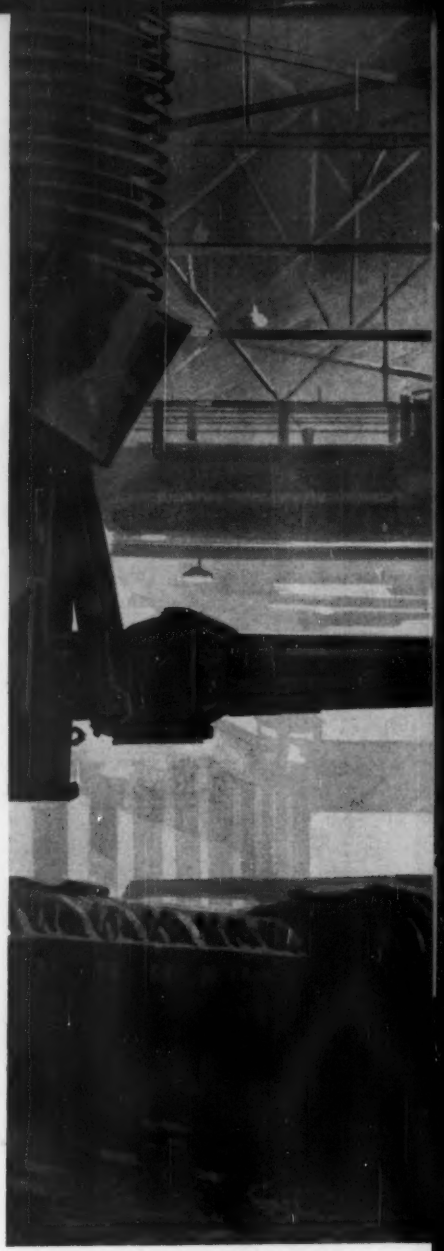

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Get top quality welds every time – even on irregular contours or in restricted areas – with Airco's new *Automatic Heliweld Head*. With this new design, you're sure of precise arc length control over *all* surfaces . . . accurate, automatic welding in *all* positions . . . vibration- and wobble-free operation *all* the time. What's more, you can set it to weld aluminum (on AC) or ferrous materials (on DC)—at the flick of a switch. Sensitivity is maintained with argon or helium.

The new Airco Automatic Heliweld Head is right at home on the toughest jobs. Internal circumferential seams, for example, are handled easily with the 3″ or 12″ offset arms. Tilting mechanism provides accurate, controlled welding through 360°.

Take your choice of two models. Model E takes electrodes up to 24″. Model D takes electrodes to 7″, and is provided with rotatable offset arms of 3″ and 12″, greatly increasing your ability to weld hard-to-reach spots.

Get full details on the new Airco Automatic Heliweld Head now. Call your nearest Air Reduction Office.

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cules. With metal additive fuels, a higher percentage of oxidizer might be used.

True film cooling of chamber and nozzle walls with a layer of fuel has been abandoned as uneconomical since regenerative cooling techniques have been improved. However, it is still customary to run the outer injection ring slightly more fuel rich than inner rings to reduce heat transfer into the walls.

From the combustion engineers' standpoint, problems posed by the big boosters are different in degree rather than kind. As the industry strives for higher performance, propulsion systems become more sensitive to combustion instability. Since the gas volume in a larger thrust chamber has a lower natural frequency, amplitude of waves is greater and higher energy levels in them increase the danger of instability. However, instability has reached the status of a routine engineering problem and Rocketdyne engineers see no reason to doubt their ability to cope with it.

Computer Technology

Rocketdyne combustion engineers expect that improved mathematical tools and greater use of computer technology will soon eliminate much empirical testing by providing more reliable theoretical predictions. This trend is already being felt and the research specialist is beginning to make real contributions in the development phase. Combustion experts also report more detailed understanding of combustion among hardware designers than was formerly the case. This is signified by the gradual disappearance of such terms as "flame front" or "vaporization zone." It is becoming more widely realized that if there is such a thing as a flame front or vaporization zone, it is wrapped around the propellant droplet, whose behavior is at the heart of combustion phenomena.

Nickel Tubing

In current thrust chambers, Rocketdyne has used wall tubes of garden variety nickel because of its good thermal conductivity, corrosion resistance, and ease of forming. In advanced systems now being designed, this practice will be stopped and tubes with a higher strength-to-weight ratio will be used. Inconel-X is the most likely candidate. It offers a strength of 100,000 psi., compared with 8,000 psi. for nickel.

Turbine wheels in the big boosters will be forged of Rene 41, cobalt-base alloy.

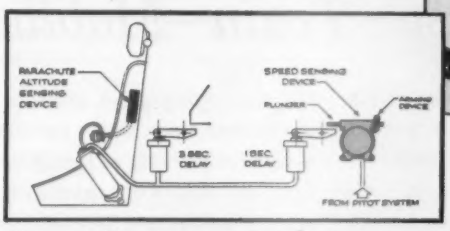
It is reputed to be more weldable than competitive materials and at the temperatures anticipated, it has about the highest strength to weight ratio of any material available. For some purposes Rocketdyne would like to use

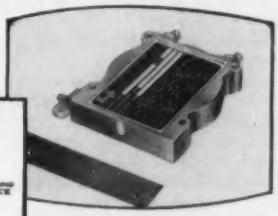
new EMERGENCY ESCAPE DEVICES
solve Automatic Sequencing Problem!

When a pilot ejects at high speeds, seat-man separation is delayed two seconds to prevent injury and parachute tearing. *However, this delay at low altitudes, where ejection is rarely made at extreme speed, may prevent full parachute opening before the pilot hits the ground!*

To reduce this delay and to increase pilot safety at low altitudes, Pacific Scientific has developed a *Speed Sensor* and a *Parachute Release Actuator* for the Air Force that cuts the two second delay to one second – and deploys the parachute in less than 1/10th second! In addition, these two devices permit a three second delay at high speeds – and high altitudes – thus providing the correct sequence of automatic seat separation and parachute deployment under any condition!

Both devices are unusually simple, rugged and dependable. And they are designed to permit easy installation on existing equipment at little cost! This is *the type of reliable engineering ingenuity Pacific can offer your company... the capability to resolve perplexing problems with practical, simple solutions.*





Pacific's miniature Speed Sensor (above) and Parachute Altitude Sensing Device (indicated in diagram) are the key elements in this new Emergency Escape System.

If your problem is in controls, instruments, or safety equipment, discuss it with Pacific. Do so today!

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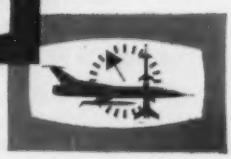


CREATIVE MANUFACTURING AND DEVELOPMENT OF AIRBORNE CONTROLS.

REPORT FROM ***ARMA***

The Missile Train—Mobile Sunday Punch

In the foreground above is the missile train—a hit-and-run Sunday punch for our modern Army. In event of war, the train could fire a missile with nuclear warhead, move rapidly miles away, then fire other missiles . . . without becoming a vulnerable stationary target itself. The missile train would be an ever-present threat to the enemy's tactical units over a wide area.

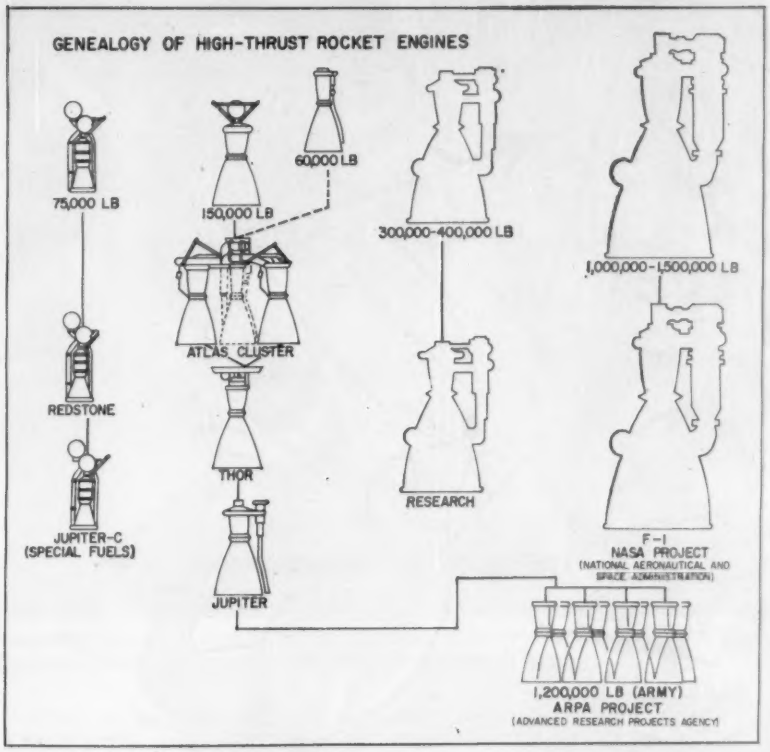
For such imaginative projects as the missile train, which combines maximum mobility with maximum firepower, ARMA has developed an equally imaginative universal navigation system. Not only can ARMA systems rapidly locate and aim all types of Army missiles, but they are applicable to all types of land, sea and air operations. To the Army, ARMA offers precise vehicular navigation systems for use in artillery and missile survey, combat vehicles, tanks, and helicopters as well as remote control types for mine detection and atomic blast survey. Precision navigation systems are ARMA's business from ships to ICBM's and—beyond.

ARMA, Garden City, N. Y., a division of American Bosch Arma Corp. . . . the future is our business.

Attention, Engineers: Write to E. C. Lester, Emp. Supv., about career openings in R&D programs.

6826

AMERICAN BOSCH ARMA CORPORATION



GROWTH of nation's high-thrust liquid propellant rocket engines is detailed above, starting with Redstone up to the 360,000 lb. thrust of the Atlas ICBM.

molybdenum but it is a catalyst which initiates decomposition of hydrazine and company designs its product for easy conversion to storable propellant systems.

Compatible Coatings

Coatings that are compatible with storables and high energy fuels are being applied to otherwise conventional components to provide the widest range of temperature and corrosion resistance. Among the coatings being used are aluminum and zirconium oxides which are flame-sprayed or plasma-sprayed upon the exposed surfaces. These coatings are hard to use because their lack of ductility and usually have different thermal expansion coefficients than the base metal upon which they are applied. Rocketdyne has adopted the practice of gradually increasing the oxide proportion in successive layers to improve ductility and resist separation of coating and base.

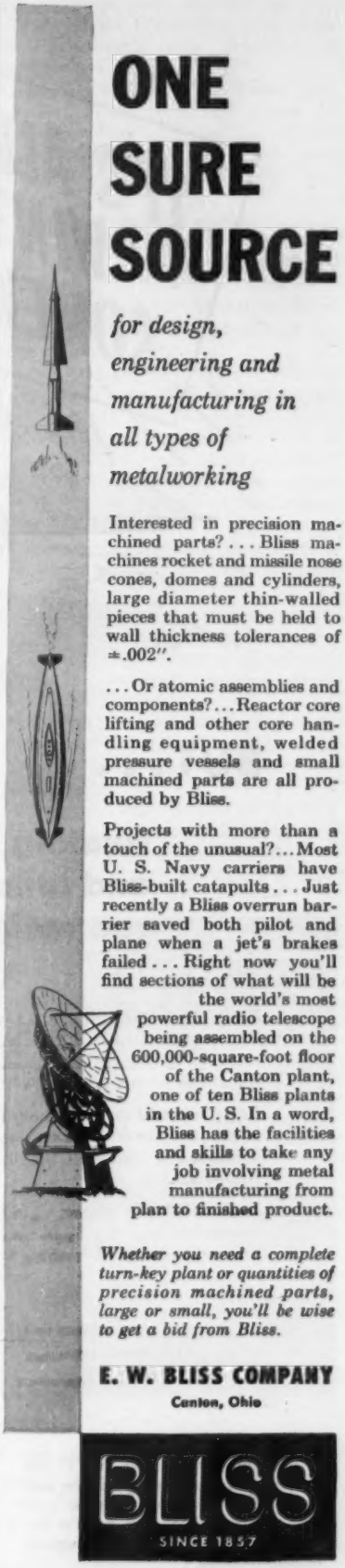
Uncooled nozzle skirt, now being sought to reduce demands upon turbopump or increase pressure drop across the injector face, is a challenging materials problem. Increasing use is being found for aluminum castings with beryllium additive. Beryllium increases ductility and pushes yield strength up from 17,000 psi to 32,000 psi. Material is called Tens-50 and much of it is used in auxiliary power units.

Rocketdyne researchers have found that high energy propellants and storables cause fewer problems than originally feared. Toxicity of high energy propellants now is considered a development problem, rather than one calling for a major technological advance. A goal of propellant chemists is to cram as much hydrogen as possible into fuels and as much fluorine as possible into oxidizers. Hydrazine and nitrogen tetroxide, the most popular storable propellant combination now coming into use, is regarded as only a starting point by Rocketdyne propellant scientists. They expect to leave this combination far behind in the future. Use of storables complicates turbopump design because turbines must operate 500 to 600 deg. hotter than with conventional propellants.

REAP Program

Many of the techniques which have made possible the present generation of large thrust units grew out of a $6 million Air Force-funded Rocket Engine Advancement Program (REAP) which began in 1952 and lasted four years with the purpose of advancing component state-of-the-art. Some observers are convinced that a new REAP program would yield rewards comparable to those obtained in the earlier one. Products of that program were:

• **Substitution** of gimbaling thrust



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Interested in precision machined parts? . . . Bliss machines rocket and missile nose cones, domes and cylinders, large diameter thin-walled pieces that must be held to wall thickness tolerances of ±.002".

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Whether you need a complete turn-key plant or quantities of precision machined parts, large or small, you'll be wise to get a bid from Bliss.

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Heating Blankets and other Woven Heating Elements by SAFEWAY can make your COLD problems OLD problems!

Be it the frigid altitudes at which manned aircraft fly, the cold, trackless space domain of missile and satellite, or the icy arctic wastes of DEW Line installations — it's always "winter" somewhere.

Environmental temperature problems common to this kind of "winter" beset fuels and lubricants and hamper the operation of many types of sensitive equipment.

But SAFEWAY dispels such problems by packaging *controlled heat* for application *everywhere*. Among the wide variety of heating blankets and woven-wire heating elements which have been engineered by SAFEWAY to meet exacting specifications are:

- **heating elements for launching equipment and for airborne gyros, cameras, computers, servos and batteries — for missiles or aircraft**
- **de-icing units for airfoil surfaces**
- **heating elements for all types of ground support equipment**
- **defrosting units for industrial and commercial refrigeration**
- **heating blankets for honeycomb and metal-to-metal bonding**

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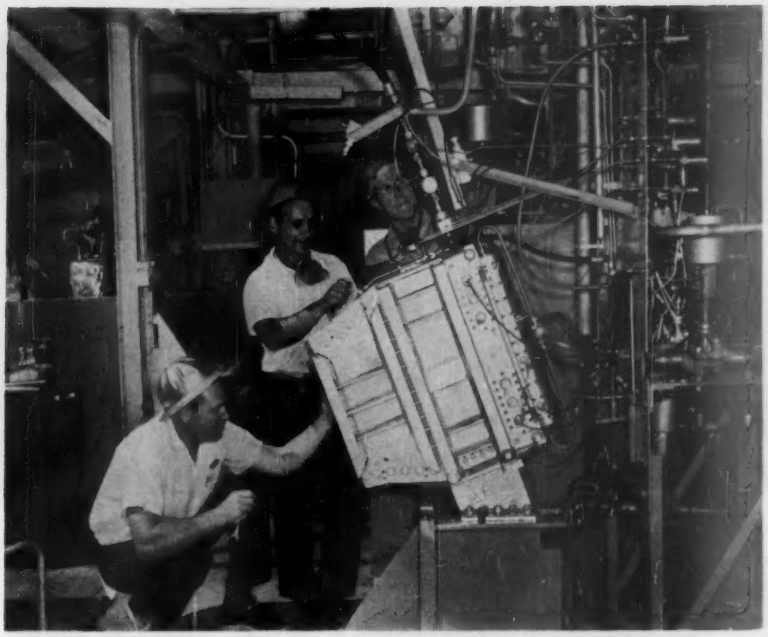
If it has to be heated (and the "it" can be just about anything), you can rely on SAFEWAY engineers to study your problems carefully, and — without any obligation — submit an appropriate recommendation.

Safeway HEAT ELEMENTS INC.

680 Newfield Street • Middletown, Connecticut



CAMERAS photograph combination and fluid dynamics phenomena in this two-dimensional model of a thrust chamber. Cameras are in quartz windows at upper end.

chambers for thrust vectoring vanes.

• **Development of tubular** wall thrust chambers to replace double-wall construction.

• **Adoption** of petroleum fuel such as RP-1 as replacement for alcohol.

• **Development** of propellant pumps able to work at low entry pressures.

• **Development** of a bell-shaped nozzle to get higher expansion ratios for nozzle length than straight expansion cone.

• **Bootstrap turbopump** development to replace separate monopropellant system used in earlier versions of liquid propellant rockets.

One big advance Rocketdyne would hope for in a new REAP program is a way to produce lighter, cheaper propellant injectors easily. Present injectors are hogged out of heavy steel block at considerable expense. Rocketdyne has tried cast and sheet metal injectors but without any notable success.

Some of the noteworthy steps taken in Rocketdyne's own simplification program are:

• **Adoption in H-1 Saturn** engine and advanced Atlas propulsion system of solid propellant cartridge starters for turbopumps to supercede heavy, pressurized starting tanks of liquid propellant.

• **Tapping of chamber pressure** to drive the turbopump, thereby eliminating separate gas generator and its propellant lines.

• **Design** of turbine exhaust aspirator manifold first as a shroud around the edge of nozzle skirt.

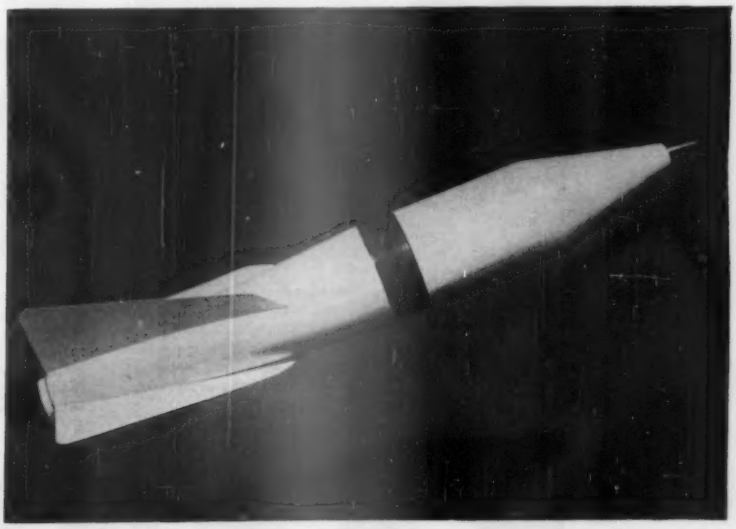
• **Later design** of turbine exhaust "dump-back" manifold to feed secondary hot gas back into main thrust chamber efflux through interstices in the nozzle skirt wall about one-third of the way downstream from nozzle throad to the bottom of the nozzle skirt.

• **Mounting** of turbopump directly upon the thrust chamber to eliminate high pressure flexible tubing.

• **Abolition** of cautious three-phase prestart ignition sequence originally developed by the Germans in favor of "shot gun" start with immediate operation at full thrust.

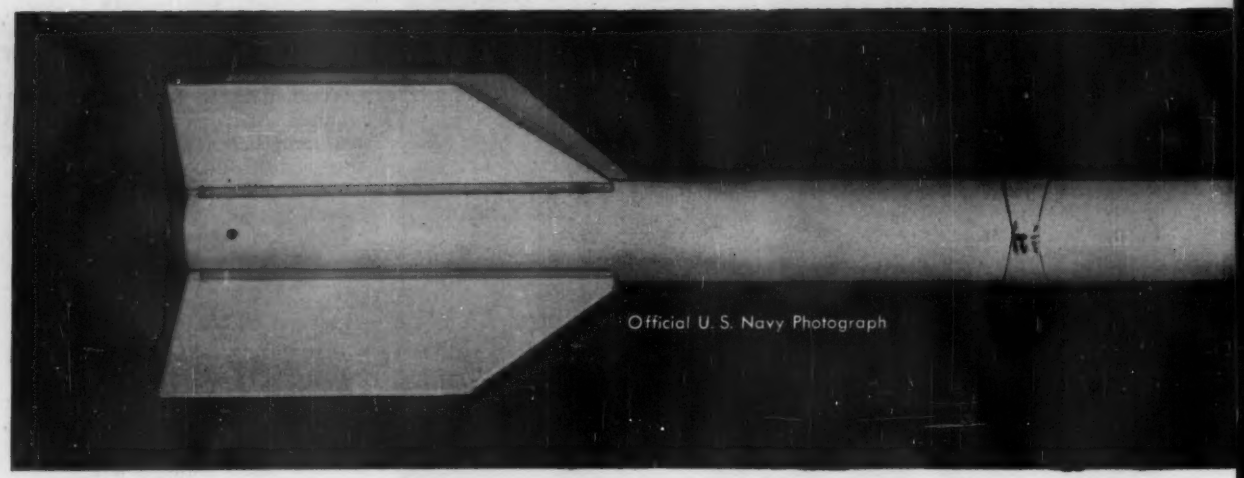
• **Adoption in Atlas MA-3** propulsion system and H-1 propulsion system of Saturn of fuel pressure sequenced fuel control valves.

Progressive simplification of this first family of large American liquid propellant rockets owes at least as much to grinding detail engineering as it does



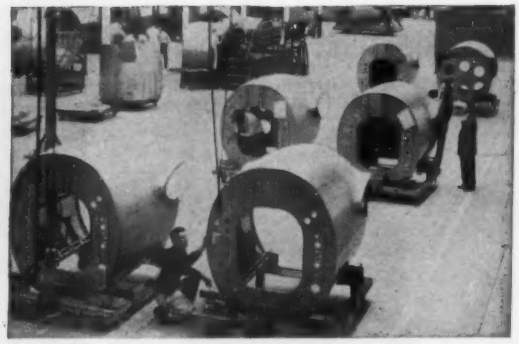
Rescue Rocket Sprays Oil on Waves

Fired from a crossbow-type launcher, this new German rocket is designed for rescue work, and sprays a thin film of oil over a 90,000 sq. ft., surface to smooth rough waves. Rocket has a range of 900 ft. and carries one quart of oil which is ejected through small openings in the nose cone and around its center. A shield on the launcher protects the "archer" from the hot exhaust. Fins on the model of the rocket (right) are canted to spin it around its longitudinal axis. Rocket was developed by (West) German Rocket Society and is expected to go into mass production next year.



REPUBLIC TITANIUM is used in dozens of structural components and details in the Martin P6M SeaMaster, including engine nacelle center beams such as the one illustrated. Commercially pure titanium and titanium alloys supplied by Republic increase strength and heat resistance, reduce weight. Republic Titanium Alloys are among the strongest produced, offer exceptionally high strength values at elevated temperatures.

REPUBLIC'S NEW, TYPE HS6460 METAL POWDER is ideal for sinterings of highly stressed components in aircraft and missiles. Provides minimum tensile strength of 60,000 psi at 6.4 density as sintered . . . 100,000 psi after heat treatment. Less than .004% shrinkage from die size at 6.4 density. Available in quantities up to and including 12 tons or multiples. Can be used with existing operating equipment. Mail coupon for technical data sheet.



REPUBLIC ENDURO® STAINLESS STEELS—types 301 and 302—are currently being used by Solar Aircraft Company in the fabrication of complete engine nacelles for Navy P2V patrol bombers. Stainless construction offers greater strength, permits use of lighter gages, increases corrosion and high temperature resistance. All types are readily formed into desired shapes by the usual commercial methods. Send coupon for complete information.

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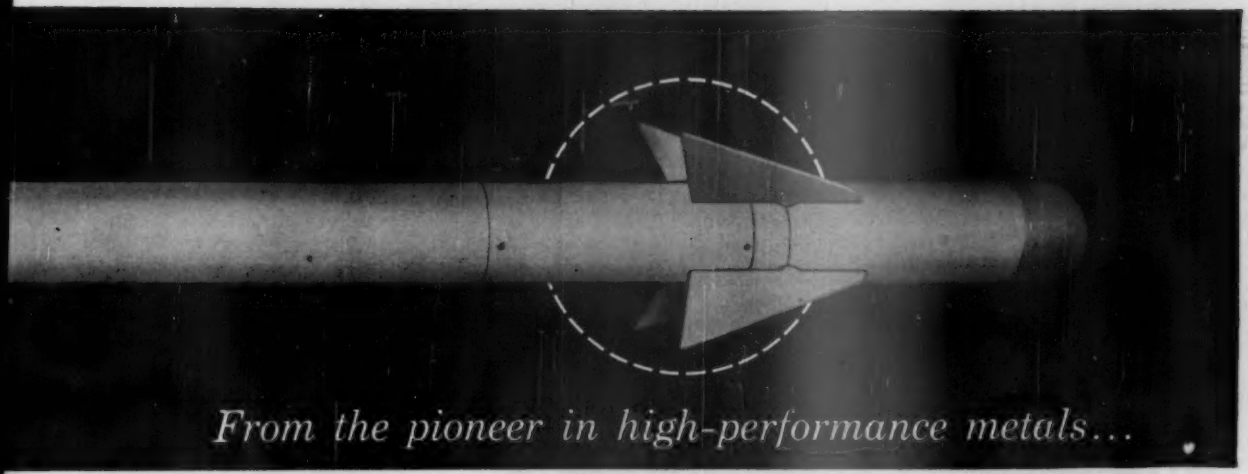


From the pioneer in high-performance metals...

TYPE 4130 ALLOY STEEL FINS FOR THE SIDEWINDER

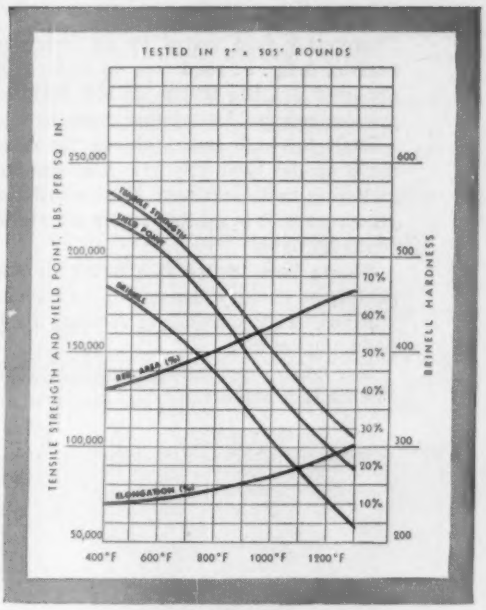
Close-tolerance, delicately contoured fins for the Sidewinder air-to-air missile are currently being produced from Republic Type 4130 Alloy Steel by the Storms Drop Forging Company, Springfield, Massachusetts. Choice of this high-strength alloy, according to Storms, was dictated by extreme performance requirements.

Republic 4130 offers exceptionally high strength-to-weight ratios with the highest strength values. As seen at right, tensile strength in the heat-treated condition is over 230,000 psi after tempering at 400°F., with a Brinell Hardness of 460. Uniform response to heat treatment assures complete deep-hardening penetration.

The Storms Drop Forging Company reports no production difficulties involved in the use of Republic 4130. Fins are produced from hot-rolled 1½" diameter 4130 bars in successive forging, hot trimming, grinding, wet tumbling, and coining operations.

Republic has pioneered in the development and production of new metals to resist heat, reduce weight, or increase strength. With constantly expanding research as well as production facilities and capabilities, Republic stands as the nation's largest producer of *high-performance* metals—titanium, stainless, and alloy steels.

Let us help you find the most advantageous use of these metals in *your* project. Return the coupon for complete information without obligation. Please indicate if you would like a Republic Metallurgical Specialist to call.



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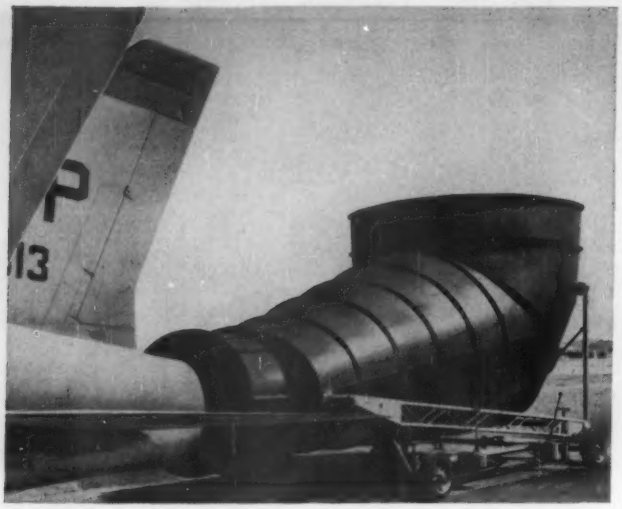


Maxim JEM-8 Silencer on run-up duty on F8U.

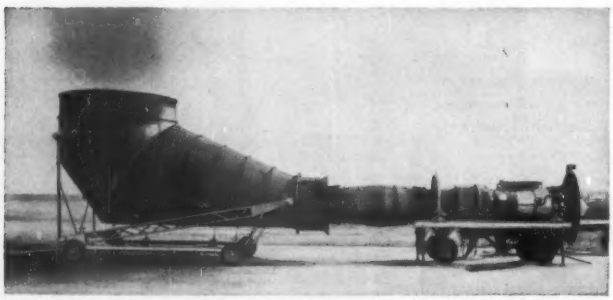
MAXIM CUTS NAVY JET NOISE 25-30 DB

Thoroughly field tested by an independent acoustical engineering firm . . . requiring no water even when afterburners are used . . . the Maxim JEM-8 Mobile Exhaust Sound Suppressor reduces jet exhaust noise by 25 to 30 dbs.

Built for high temperatures, the JEM-8 is a portable, all-metal spoiler type unit with a maximum weight of 10,000 lbs. including undercarriage. Engineered for all present types of jet aircraft, it is available with adapters for various airframe configurations.

Shown here in use at a naval air station, the JEM-8 will shortly be on duty at many other Naval and Marine Corps air stations. A commercial jet version, the JEC-8, is available for pod hung engines.

For noise suppression, consult Maxim — for it is here that Silence Is A Science.



JEM-8 with undercarriage raised for test stand.

SEND FOR FOLDER "JET ENGINE SILENCING"

Emhart Manufacturing Company
Maxim Division / Dept. 75
Box 216, Hartford 1, Connecticut

EMHART

to these major steps in technique improvement.

In developing 1.5 million lb. thrust F-1 booster, Rocketdyne reports no important obstacle to the scaling of its non-conventional ballistic missile engines to space booster size. Perhaps the most difficult single problem encountered to date is that of obtaining a smooth start for a chamber of such large dimensions. Experience with F-1 indicates that development problems stem from phenomena which can be ignored in small thrust chambers but become serious in larger ones. They say there is no reason to predict difficulties of different nature from those encountered in the past.

ABMA Schedules Pershing Shots

Orlando—Initial development firings of the Army-Martin Pershing solid-propellant ballistic missile are scheduled to be made early next spring, according to the Army Ballistic Missile Agency.

Facilities for firing the missile, including the blockhouse and launch complex, have been turned over to ABMA at Air Force Missile Test Center facilities, Cape Canaveral, Fla. The two-story concrete blockhouse, which forms the apex of a triangle with two Pershing launching pads, provides 8,800 sq. ft. of usable space. The walls are two feet thick and steel reinforced, and the roof varies from eight to five feet in thickness.

The blockhouse was designed by Maurice H. Connell & Associates, Inc., Miami, and constructed by R. E. Clarkson, Inc., St. Petersburg, under the direction of the Army Corps of Engineers and the Martin Co.

In addition to the blockhouse and two launching pads, the area will contain a helicopter parking apron, a nose installation building and a service structure.

The Pershing system will have a range of up to 700 mi. and will be ground, plane and helicopter transportable.

Missile Capsule TV Will Photo Impact

Army Ordnance Missile Command has developed a reconnaissance television transmitter to be housed in a capsule carried in a ballistic missile. Capsule would be ejected during flight and, while falling to earth, would photograph impact of the missile. Device would transmit its image of the target area to television monitoring screens at command posts behind the line of battle.

NOW! Automatically Control and Test Complex Electro-Mechanical Systems

with complete reliability!

If you're having trouble testing complex electro-mechanical systems, it will pay you to investigate DIT-MCO's 250F2M Electro-Mechanical Systems Analyzer. It is specially designed to control and test integrated devices and their associated wiring by simulating controlling assemblies and monitoring their action.

Each of the Analyzer's 200 test positions can perform up to 36 independent switching functions. Its capacity to control complex systems, therefore, is almost unlimited. In each test position the 250F2M will:

1. Actuate all necessary resistive devices and provide termination-to-termination tests of each circuit for continuity and discontinuity.
2. Simulate conditions which allow it to operate and test each resistive device in the circuit under test.
3. Provide for visual measurement of resistive values and time delay constants where desired.
4. Provide switching capabilities which enable monitoring of circuit conditions with external detecting devices.

These capabilities make it possible to achieve extremely high standards with complex relay chassis and similar systems, thus eliminating borderline errors which can lead to malfunction under operating conditions.

The 250F2M uses DIT-MCO's exclusive Matrix Chart to put complete circuit information right in front of the operator's eyes. The machine is easy to operate, easy to interpret, easy to adapt to any test. Write today for full details.

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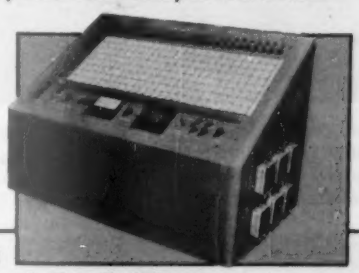
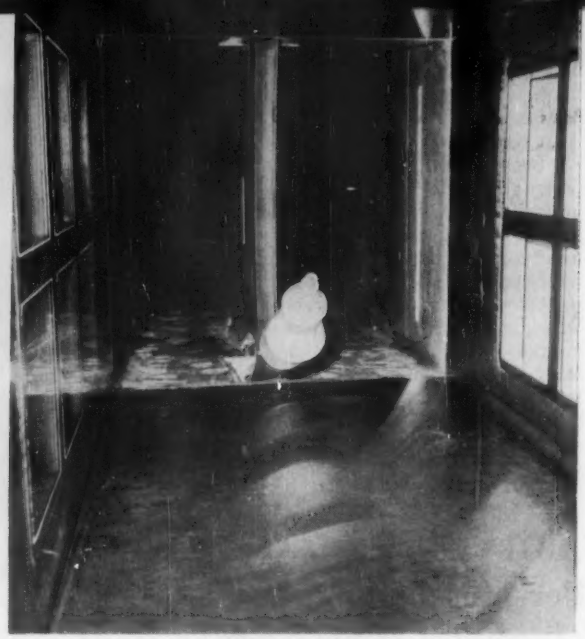


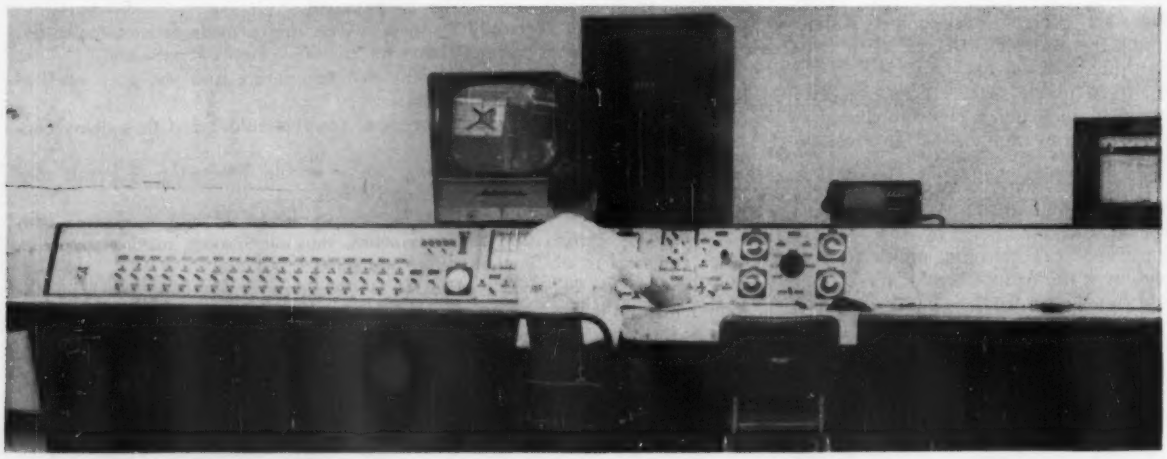
SPECIFICATIONS:

1. Continuity Test
   A. Test Voltage ..... 28 V.D.C.
   B. Continuity Current ..... 1 ampere
   C. Continuity Resistance ..... adjustable from 0.3 ohms to 10 ohms
2. Continuity-Discontinuity Test
   A. Test Voltage ..... 28 V.D.C.
   B. Continuity Current ..... 1 ampere
   C. Continuity Resistance..0.3 ohms to 10 ohms
   D. Discontinuity Resistance ..... 2.5 megohms reject, 3 megohms accept
3. Short Test
   A. Test Voltage ..... 28 V.D.C.
   B. Test Current ..... 0.03 ma (max)
   C. Short Resistance Range ..... 2.5 megohms reject, 3 megohms accept
4. Ohmmeter
   A. Range ..... 0 to 200 megohms
   B. Accuracy ..... ±3%
5. Timer (Standard)
   A. 60 minute range, 0.2 second scale division
   B. Accuracy..0.1 sec. per operation at 60 cycles
   Timer (Optional)
   A. 60 minute range, 0.01 second scale division
   B. Accuracy..0.002% per operation ±1 division
6. Power Requirements
   A. 100 to 125 V.A.C. 55 to 65 cycles (standard timer)
   B. 100 to 125 V.A.C. 50 to 400 cycles (optional timer)
7. External Energization
   A. 28 V.D.C. and 110 V.A.C., 60 cycles are provided for external energization of relays or other resistive devices, isolated from test voltage.
   B. Other voltages may be supplied by external power supplies and switched as external energization or other test purposes.

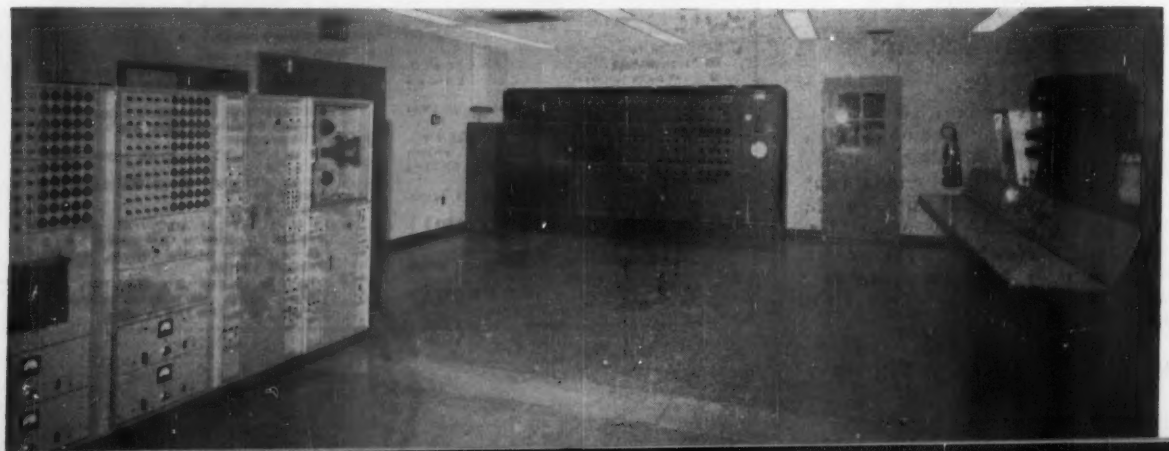


Seven per cent scale model of Project Mercury capsule is positioned (left) in throat of McDonnell Aircraft Corp.'s new wind tunnel at St. Louis prior to closing tunnel circuit. At right, model is photographed as it would appear while test is under way. Windows flank model. Tunnel, capable of measuring airflow speeds to 4,000 mph., is part of $5,324,903 polysonic airflow laboratory.

McDonnell Begins Operating Polysonic Wind Tunnel



Closed circuit television screen is used by a McDonnell engineer to monitor the polysonic wind tunnel from the control panel (above). Another view of the control room is shown below; the control panel and closed circuit television are at right, and data processing equipment is in the foreground at left. The new laboratory contains 36,852 gross square feet of floor area. In addition to the wind tunnel the building houses a thermodynamics laboratory for testing equipment and materials at temperatures from —100F to 1,200F.

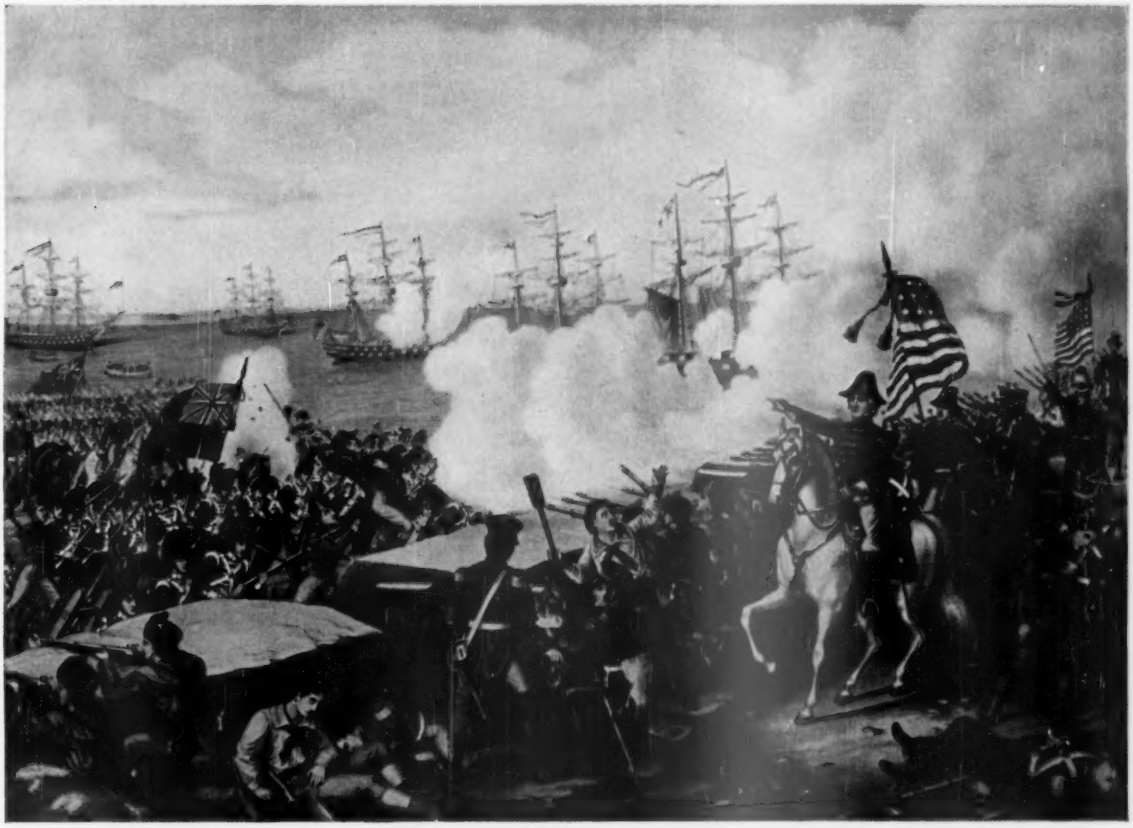


One of a series of advertisements depicting historic incidents in military communications through the ages.

GLOBAL COMMUNICATIONS—1815

The Battle of New Orleans on January 8, 1815 was fought 15 days after the end of the War of 1812. The Treaty of Ghent terminating the war between the U. S. and Britain had been signed in Europe on December 24, 1814. Yet before the news reached America, General Andrew Jackson with his motley forces of frontier militiamen, gulf pirates and a few regulars, out-numbered two to one, fought and won the memorable victory over Sir Edward Pakenham's crack line regiments—veterans fresh from victory over Napoleon. This war was but a facet of the larger global foment stirred up by the ambitions of Napoleon and the French Revolution.

The Bettmann Archive



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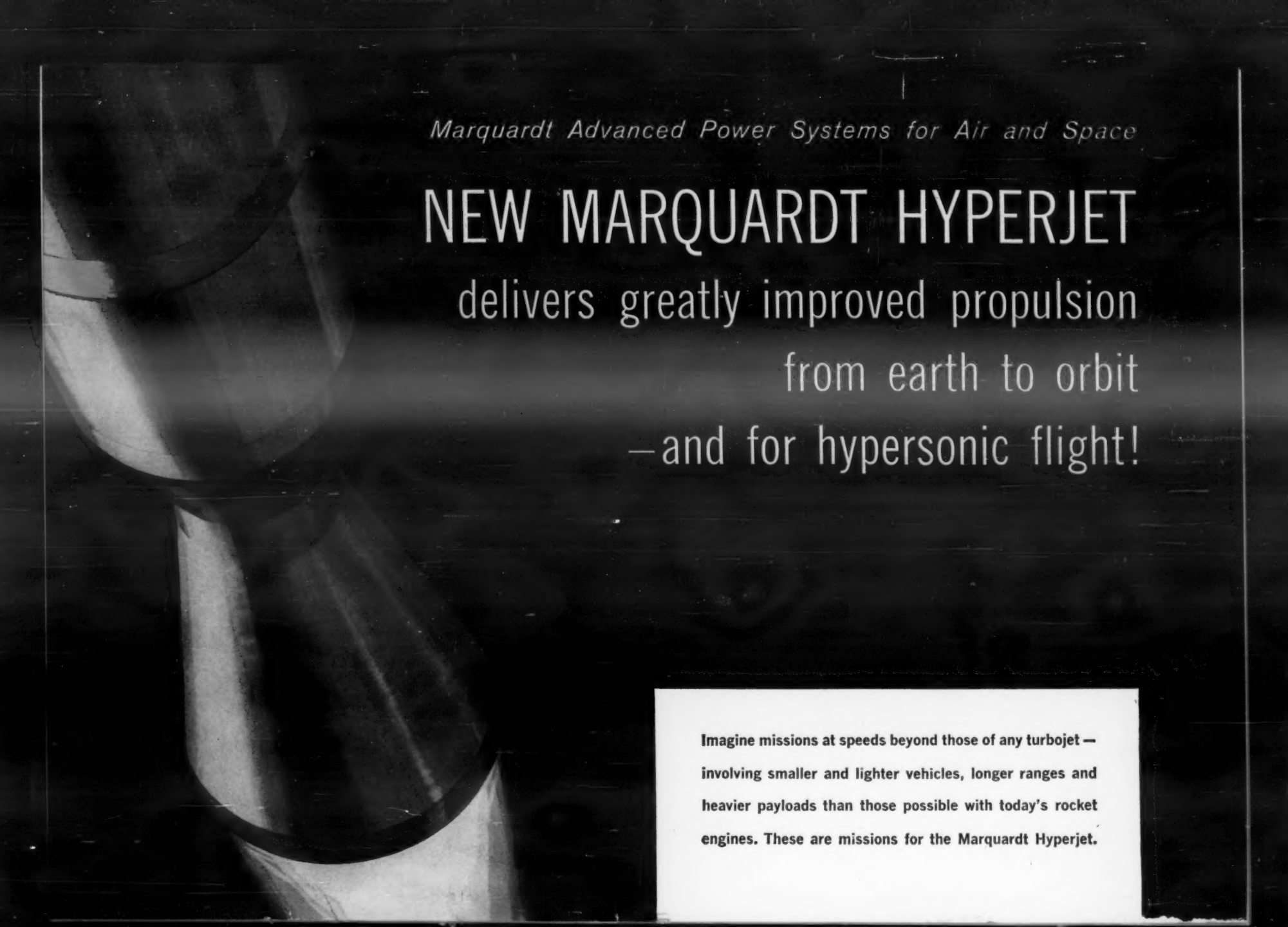

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CANADAIR CL-41 jet trainer is adaptable to four different makes of turbojet engines without structural modifications. Royal Canadian Air Force advised and coordinated with Canadair on design, which also covers RAF and USAF specifications.

Turbojet CL-41 Covers Full Training Span

By Robert I. Stanfield

Montreal—First design details of Canadair's new side-by-side CL-41 jet trainer point to a rugged, flexible airplane capable of covering the full span of student training—from primary through advanced instruction—at speeds ranging from 65 kt. (stall) to 500 kt. or Mach .8 (limit dive).

The CL-41 will be the first all-Canadair designed aircraft produced by this subsidiary of General Dynamics Corp. It was designed on a private venture basis in which, from its inception, the company has benefited by advice from the Royal Canadian Air Force.

Airplane will be powered by the 436-lb. (guarantee weight) Pratt & Whitney prototype JTC12A-2 engine, which develops 2,900 lb. of thrust but will be "derated" to 2,400 lb. for the CL-41. Canadair feels that by reducing the power it will prevent a too-steep curve for the student pilot; that at 2,400 lb. of thrust there will still be a good power margin plus availability of engine's full thrust and growth potential. JT-12 production engines, available next year, will develop 3,000 lb. of thrust, which is expected to increase to 3,300 lb. by December, 1961.

Canadair also says the reduction to 2,400 lb. will increase the margin between cruise and critical speed, increase the time interval between cruise and critical speed, increase the engine's initial overhaul period to about 900 hr. (Pratt & Whitney specifies an initial 600-hr. overhaul life for the JTC12A-2), and reduce the specific fuel flow.

The company will accomplish the power reduction by controlling the fuel flow, via throttle positioning on the engine itself. By adjusting the throttle linkage the engine will be delivering 94% power when the tachometer reads 100% in the cockpit.

Thrust Rating

At 2,400 lb. thrust—which is both military (takeoff) and maximum continuous (normal) rating—specific fuel consumption is .840 lb./hr. lb. thrust. At 90% normal rating (maximum cruise) and 75% normal rating (normal cruise) the specific fuel consumption is .820 and .815 lb./hr. lb. thrust, respectively.

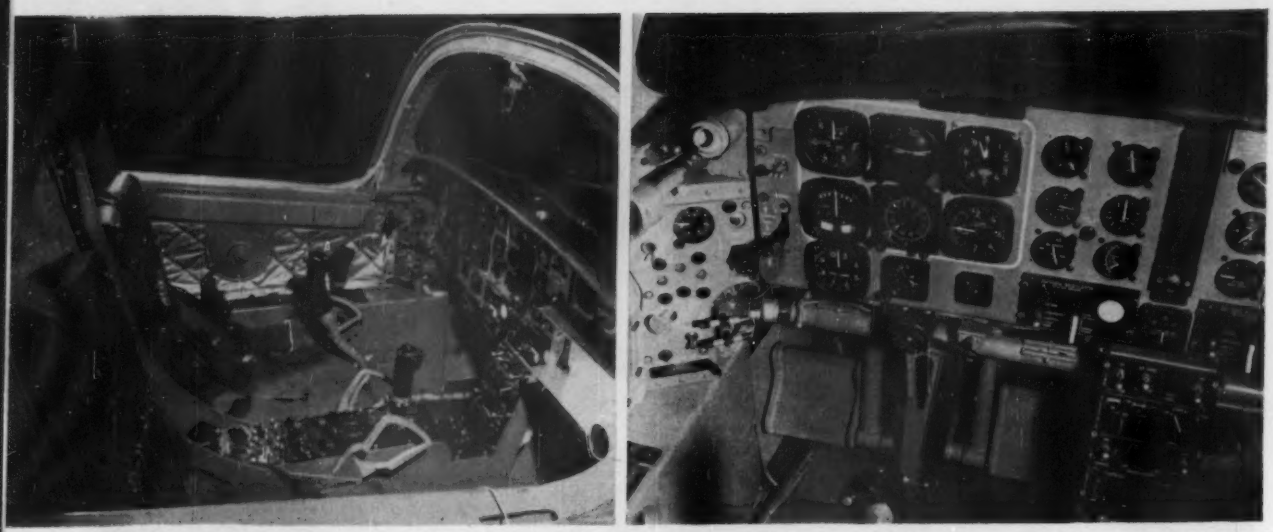
The CL-41 also is adaptable—without any structural modifications—for the following engines: the Armstrong Siddeley Viper ASV.11 of 2,460 lb. thrust, the General Electric J85 of about 2,500 lb. thrust, and the Rolls-Royce RB.145 of 2,750 lb. thrust.

Tailored to runways of less than 5,000-ft. length, the CL-41 in size and weight is comparable to the old piston-engine AT-6 advanced trainer. Span of the jet trainer is 36 ft. 4 in.; length is 32 ft.; over-all height is 9 ft. 4.5 in. Design and landing gross weight is 6,500 lb. But here the comparisons end.

Key performance and design features of the CL-41 include:

• **Takeoff-landing capabilities.** Takeoff distance, over 50 ft., sea level, is specified as 1,830 ft. Landing distance from 50 ft., sea level, at half-fuel weight (5,700 lb.) is 1,920 ft. Canadair says the CL-41 will reach (following takeoff) 600 ft. by the time it passes the end of a 5,000 ft. runway, thus accelerating takeoff traffic at training bases.

• **Climb-speed-range.** Trainer has a climb rate specified as 4,100 fpm. at sea level, 2,000 fpm. at 20,000 ft., 1,400 fpm. at 30,000 ft. Time to climb to 15,000 ft. is stated as 5 min.; to 30,000 ft., 11.7 min. Service ceiling is 44,500 ft. Range on internal fuel (plus 10% reserve) is 800 naut. mi.; with underwing tanks, 1,050 naut. mi. Maximum level speed at 30,000 ft. is 412 kt. TAS (true air speed). Typical training mis-



CENTER CONSOLE (left) contains test instrumentation and radio channel selectors. **Pilot's instrumentation layout is at right.**

Canadair CL-41 Specifications

Span	36 ft. 4 in.
Length, over-all	32 ft.
Height, over-all	9 ft. 4.5 in.
Design and landing gross weight	6,500 lb.
Max. takeoff gross weight	6,600 lb.
Usable fuel (1,750 lb. JP-4)	270 gal.
Auxiliary fuel (two 73-gal. underwing tanks)	146 gal.
Wing:	
Total area	220 sq. ft.
Airfoil section (root)	NACA 63A014
Airfoil section (tip)	NACA 63A212
Incidence, root	1 deg.
Incidence, tip	0 deg. 30 min.
Sweepback (35% chord)	0 deg.
Aspect ratio	6.0
Ailerons:	
Total area (aft of hinge)	18.5 sq. ft.
Span (each) in per cent of wing semi-span	40%
Deflection	±16 deg.
Flaps (single-slotted):	
Span in per cent of wing span	46%
Deflection	40 deg.
Speed brake:	
Projected frontal area	3.4 sq. ft.
Deflection	50 deg.
Horizontal tail:	
Total area	41.3 sq. ft.
Incidence	−1 deg.
Deflection (elevator)	25 deg. up, 10 deg. down
Vertical tail:	
Total area	17.47 sq. ft.
Rudder area	6.0 sq. ft.
Deflection (rudder)	±25 deg.
Landing gear:	
Main wheels	20 x 4.4
Nose wheel	5.00 – 5
Track, main wheels	158.74 in.
Wheelbase	133.25 in.
Turning circle diameter	37 ft.

Engine: Pratt & Whitney JTC12A-2 (engine develops 2,900 lb. of static thrust but has been derated to 2,400 lb. thrust for the CL-41).

	Jet Thrust (lb.)	Specific Fuel Consumption (lb./hr. lb. thrust)
Military rating (takeoff)	2,400	.840
Normal rating (maximum continuous)	2,400	.840
90% normal rating (maximum cruise)	2,160	.820
75% normal rating (normal cruise)	1,800	.815

sion endurance is about 2 hr. 28 min.

• **Flight consistency.** Internal fuel (270 gal.) is concentrated in the CL-41 fuselage, in five interconnecting bladder-type cells. No cockpit fuel management is necessary. Fuel, located over the center of gravity, means little trimming is required for aerobatics. Dry wings also afford consistent spin characteristics. Speed brakes (3.4 sq. ft.), extending from aft sides of fuselage, negate against exceeding limit dive speed. Ultimate maneuvering load factor is 11 g. Gear and flap retraction speeds (175 kt.) are nearly three times the stall speed. Flap extension speed is 145 kt.

• **Protective areas.** Two underfloor longitudinal skid beams, designed for a vertical load of 8g, run from the nose section aft to the center of the fuselage section. The fuel area is designed for an ultimate load factor of 24g. All heavy equipment structure (engine, battery, radios, etc.) is designed for 16g. To prevent anything from behind coming in, the cockpit area is designed for 32g. Most major lines (controls, wiring, etc.) run through the unpressurized, protected tunnel formed by the two skid beams. Laminated windshield is designed to withstand the impact of a 2-lb. bird at 200 kt. EAS.

• **Cockpit and pressurization.** Roomy cockpit is 55 in. wide, sill-to-sill (explaining capability of installing fuel in fuselage, plus any of four engines). Airplane is designed for ground-level ejection seats; the prototype uses Weber seats (the same as installed in USAF's Cessna T-37 trainer). Pressurization, at 3 psi., commences at 8,000 ft. altitude. Cabin altitude at 20,000 ft. would be 12,000 ft.; at 38,000 ft. it would be 20,000 ft. Cabin altitude at 44,500 ft. would be 25,000 ft.

• **Maintenance ease.** About 90% of the

aircraft is accessible without ladders. Hinged doors at waist-level provide access to the radio-avionic bay in the nose section. Hinged doors in the unpressurized tunnel along fuselage underside allow access to controls and wiring runs and hydraulic piping. "Wet" runs go down the left side of the aircraft, "dry" runs down right side, allowing work on both sides without interference. Doors on the fuselage underside aft of the rear spar provide access to the engine. The rear fuselage section can be quickly removed for major inspections and engine changes. Seats can be removed with canopy raised about 110 deg. Total access panels number 45.

Two Prototypes

Canadair has built two prototypes. The first of these, now undergoing ground runs, will make its initial flight under civil license on or about Dec. 15. Engines for these aircraft will be loaned by the Canadian Pratt & Whitney Division of United Aircraft Corp., which participated in the design of the JT12 at the U.S. Pratt & Whitney facilities at East Hartford, Conn., where the engine is produced. The second engine is scheduled for delivery to Canadair sometime this month.

Most immediate customer possibility for the CL-41 is the RCAF, which advised and coordinated with Canadair on the design of the trainer. The design also covers USAF and RAF military specifications. While Canadair is not overlooking a commercial adaptation of the CL-41, its initial concern is procurement of military orders.

Since the trainer was developed on a private venture basis, Canadair controls the rights to license it around the world.

The company is in the position —under current planning—to effect foreign deliveries by the end of 1961, and is equipped to produce 10 to 15 aircraft per month.

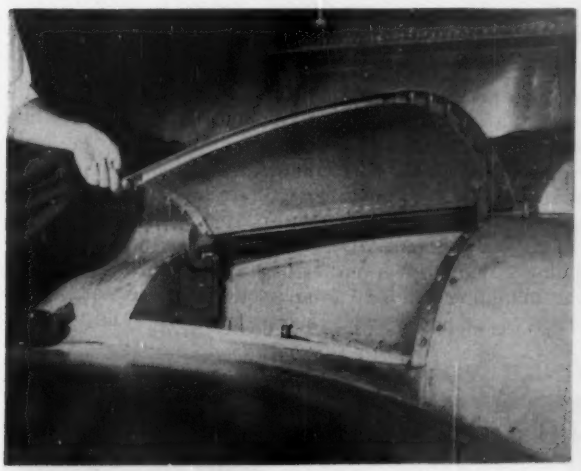
Basic airplane flyaway price would approximate $160,000, inclusive of basic instrumentation and radio-navigation equipment, but less engine. Including the powerplant, cost could approximate $195,000-$200,000. Price would vary with engine type and systems mated with a particular engine. Canadair can make available two models for price competition—the "de luxe" CL-41A and, using the second prototype, an "economy version" CL-41B.

The former, which will be powered by the JTC12A-2, will be completely equipped, including nose-wheel steering, student's blind-flying panel, airspeed indicator and Machmeter, engine air intake screens, complete radio-navigation equipment, etc. The "B" version, powered, for instance, by the Viper ASV.11, would not include these items except that the airspeed and Mach number would be combined in a single instrument (Smith's) and radio-navigation equipment would be minimized. Accessories would be at the option of the purchaser.

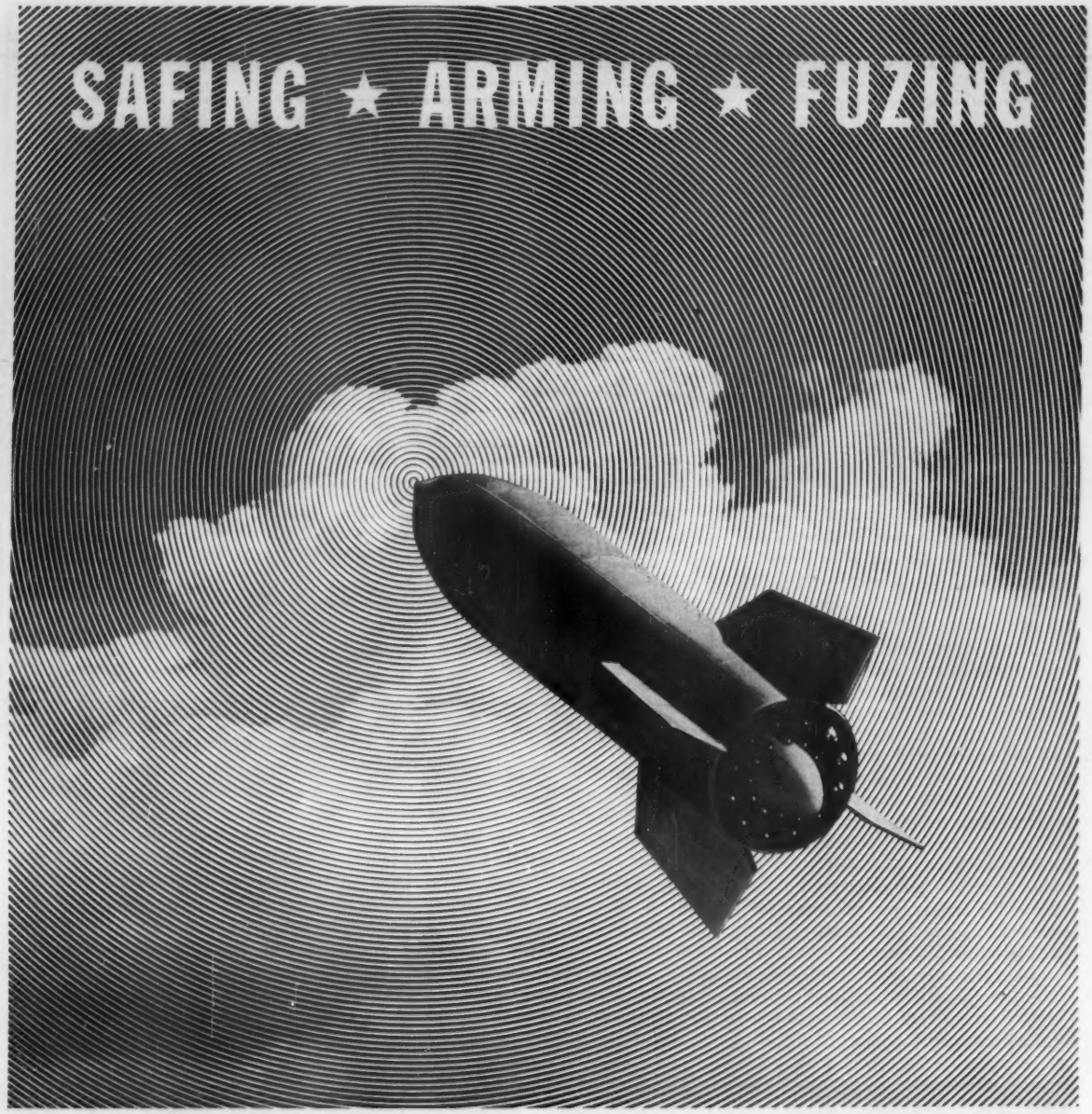
Fuselage of the CL-41 is all metal,

Canadair CL-41 Performance

Design and landing gross weight	6,500 lb.
Maximum takeoff gross weight	6,600 lb.
Takeoff distance (to 50 ft., sea level)	1,830 ft.
Landing distance (from 50 ft., sea level)	1,920 ft.
Rate of climb, (sea level)	4,100 fpm.
Rate of climb (30,000 ft.)	1,400 fpm.
Time to climb to 30,000 ft.	11.7 min.
Range (internal fuel only, plus 10% reserve)	800 naut. mi.
Maximum range (including two 73-gal. underwing tanks)	1,050 naut. mi.
Service ceiling	44,500 ft.
Maximum level speed (sea level)	385 kt. TAS
Maximum level speed (30,000 ft.)	412 kt. TAS
Limit dive speed	500 kt. EAS
Limit Mach number	Mach .80
Stalling speed (landing configuration)	65 kt. EAS
Limit flight load factor (maneuver)	+7.33 to −3.00
Limit flight load factor (gust)	+6.38 to −4.38
Maximum Range Mission:	
Range (internal fuel only)	800 naut. mi.
Cruise altitude	38,000 ft.
Average cruise speed	311 kt. TAS
Total time	2 hr. 25 min.
Landing reserve (10% internal fuel)	175 lb.
Typical Training Mission:	
Start, taxi, takeoff	5 min.
Climb to 15,000 ft.	5 min.
Medium and steep turns (15,000 ft.)	10 min.
Stalls and recoveries	5 min.
Forced landing practice	12 min.
Return to base (sea level)	5 min.
Circuits and landings	42 min.
Reserve (stand-off at 5,000 ft.)	64 min.
Total time	2 hr. 28 min.



STORAGE space for personal equipment is provided near wing roots (left). View at right shows layout of radio and avionics gear in the trainer's nose section.



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SPEED BRAKE closeup is at top. Debris guard for engine intake duct (below) is in partially open position. Screen is closed on the ground, retracts when gear goes up.

semi-monocoque, and is constructed from aluminum alloy formed frames, bulkheads and skins, with longitudinal beams underneath and four extruded longerons. Rear section, with empennage, is detachable. Wing loads are distributed into the fuselage at front, main and rear spar wing attachment bulkheads. Vertical fin loads are transmitted by integrating the fin spars into the fuselage structure. Bracing structure at engine trunnion positions carries thrust, inertia loads from engine.

Canopy Structure

Canopy structure is of extruded and formed framed sections and two formed acrylic panels, hinged at the aft end. Pressure seals are attached to boundary frames. Canopy is held in closed position by three hooks in each sill and is further supported by a ledge at the windshield hoop frame. Minimum downward vision over the nose, in static ground position, is 11.5 deg. Canopy, jettisonable from either seat, is normally opened and closed by an electrical actuator; a mechanical standby system is manually operated.

Nose section contains electronic and oxygen equipment. Access doors opening on both sides of the nose section top also give access to stowed electrical equipment and the battery.

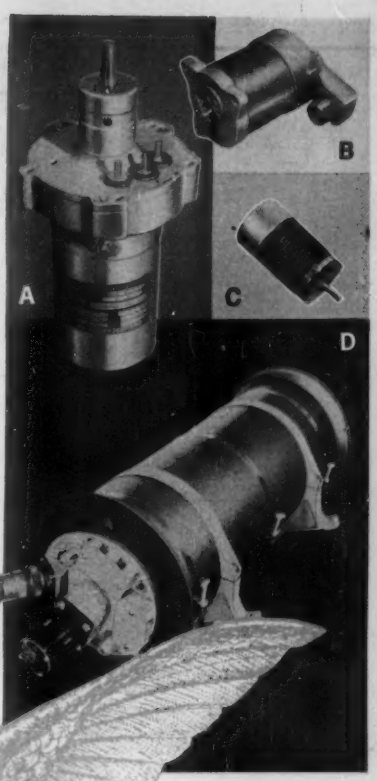
Wing is of a single main spar and stressed skin design supplemented by two auxiliary spars providing attachment for leading and trailing edge assemblies. The three spars and skin panels form a two cell box primary

A Emergency Feathering Torque Motor: 92 inch pounds torque, weighs 7.2 lbs., continuous duty, 400 cycle AC.

B Auxiliary Motor: 2.25 HP, weighs 3.9 lbs., intermittent duty, 28 volt DC.

C General Purpose: 0.14 HP, weighs 15 oz., continuous duty, 400 cycles AC.

D Helicopter Prime Mover: 240 HP, weighs 188 lbs., continuous duty, 400 cycle AC.



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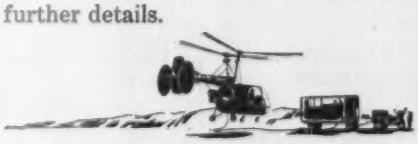

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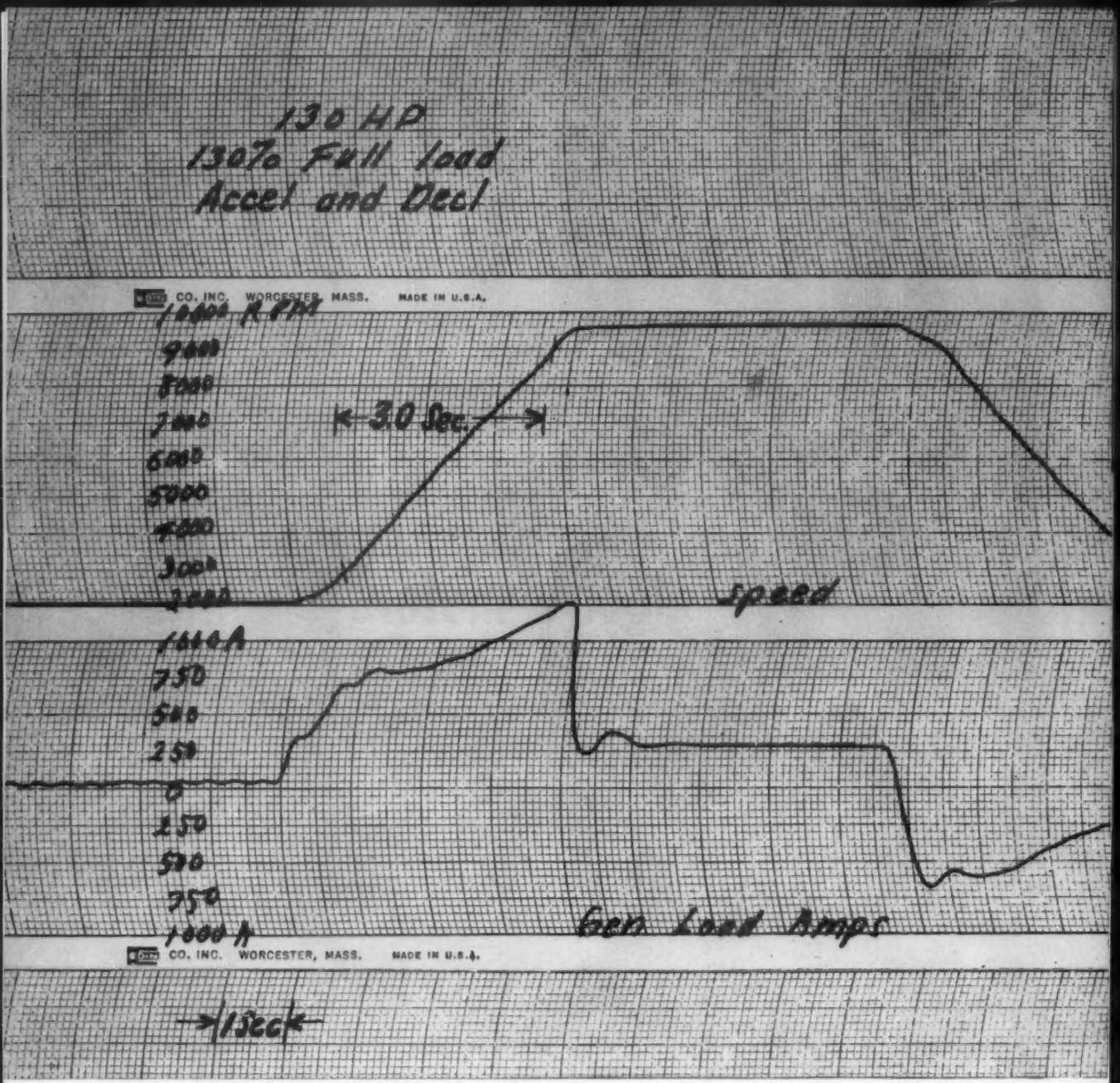

2000 RPM/second at 130% full load...

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Other outstanding performance characteristics of this dual 100/200 hp test installation are:

Speed adjustments: from 100 to 11,000 rpm
Speed deviation: 100% load change—not over 1%
200% load application—not over 2%
Recovery time: 200% load application — not over two seconds
Drift: ± 0.25% in eight hours
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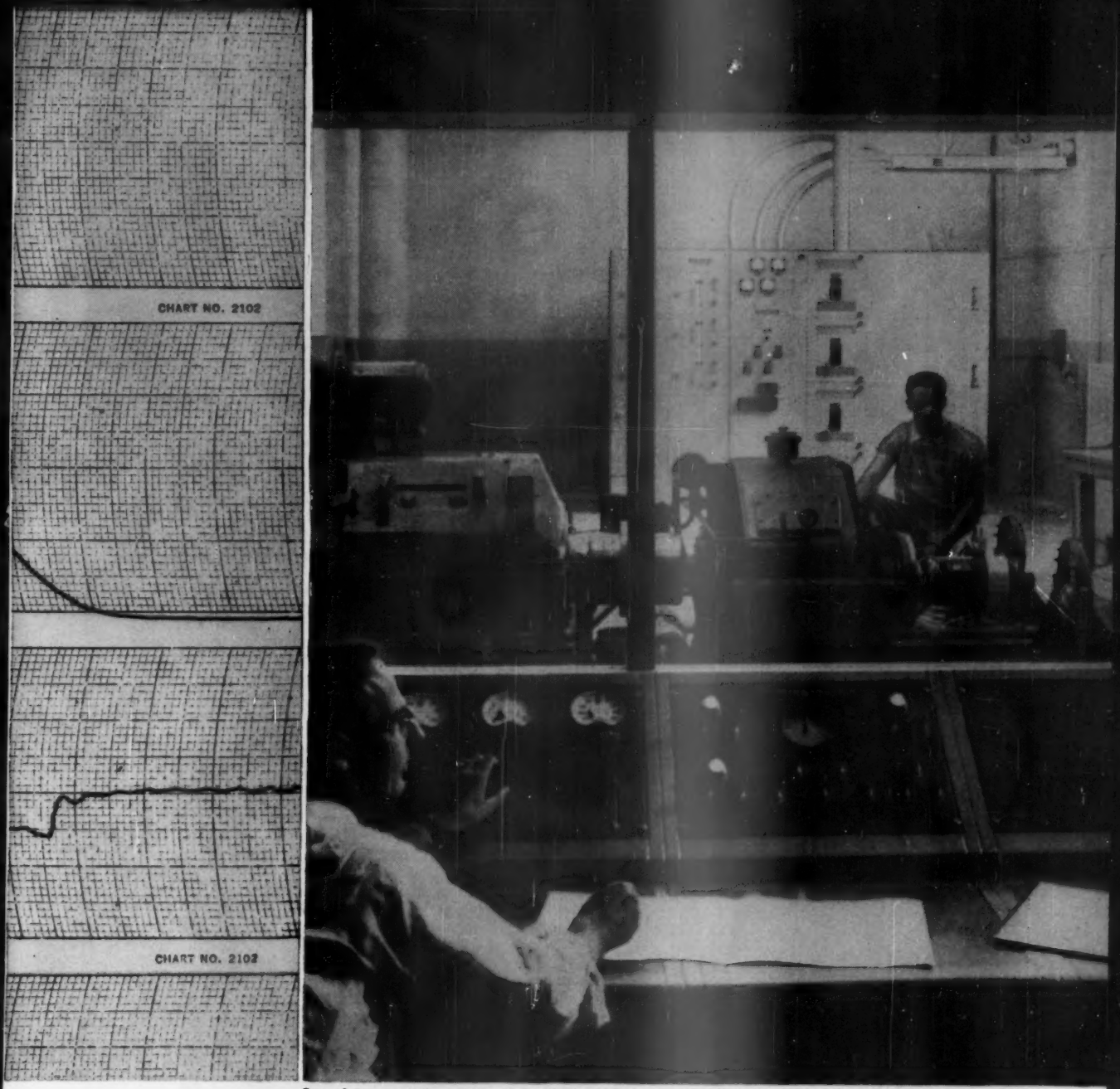
Outstanding features include:

Two output gear boxes each provide 100 hp for their respective AND pads (dual or single mount).

Twin-drive systems operate independently, or they can be combined for 200 hp delivery from the gear box at either end.

For testing alternators or for complete aircraft/missile electrical systems, Westinghouse test stands permit accurate simulation and evaluation of voltage regulation, transient response, overload capacity, paralleling operations and shock loading.



One of two control consoles of the North American Aviation, Columbus, alternator stand showing one main drive motor and speed increaser with incoming switchgear and motor control centers in background.

using Westinghouse alternator test stands

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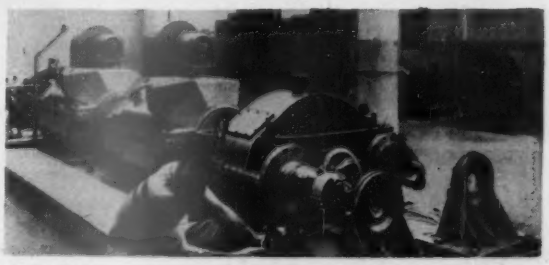

Complete dual end d-c drive showing two of four AND pads with aircraft alternator being prepared for testing. Main motor generator sets and dual test-drive control in background. J-92007

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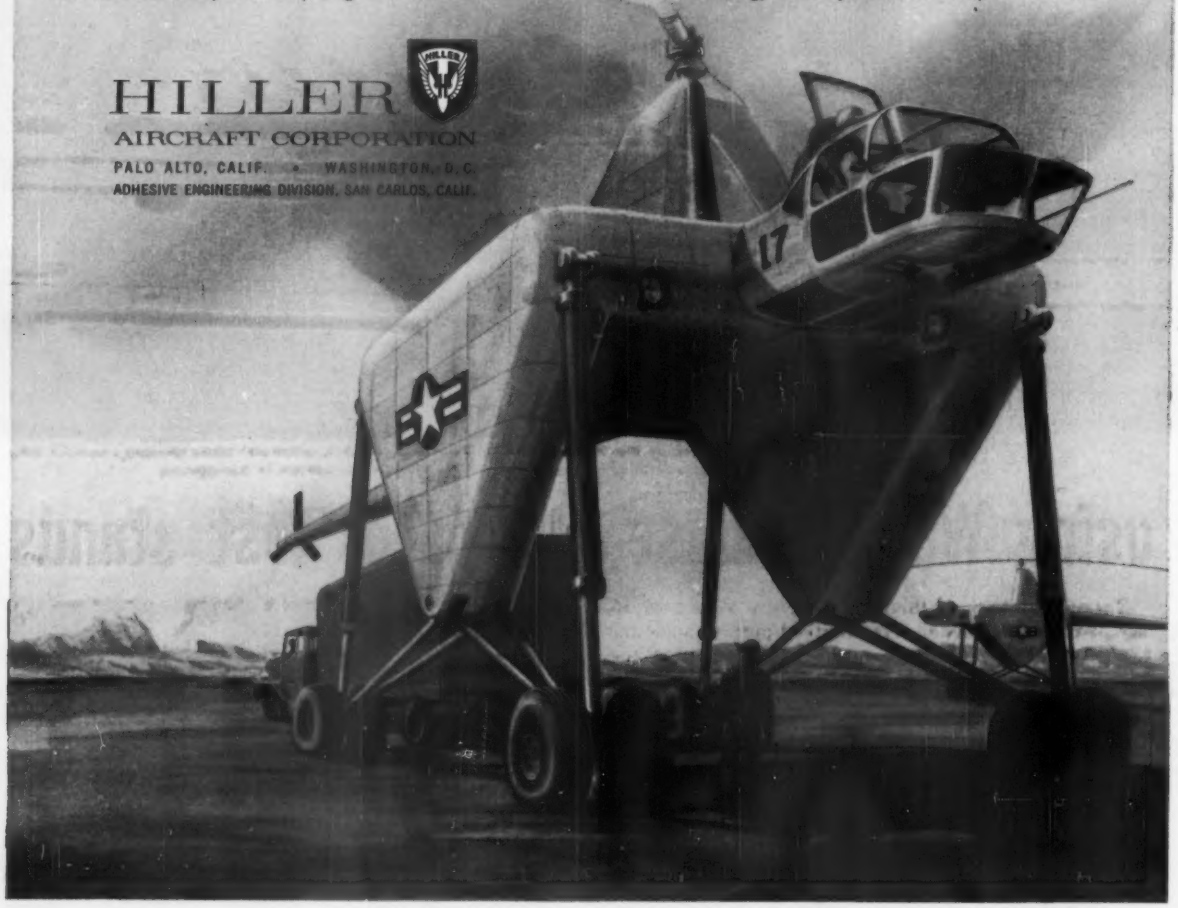
ADHESIVE ENGINEERING DIVISION, SAN CARLOS, CALIF.



structure. Left-hand and right-hand boxes are attached, to fuselage sides by bolts located in the top and bottom caps of the main spar and by single bolts at the front and rear spars.

Detachable tip of the 30-in. span is fitted outboard of the outer aileron hinge rib. Aileron movement is 16 deg., up and down. Construction of the wing is of aluminum alloy formed parts, aluminum alloy skins and extrusions. Wing trailing edges are of honeycomb construction; main wing panels are chemically milled. Lower cap of the main spar is constructed from two separate extruded angles to preclude the possibility of fatigue cracks propagating across the complete spar cap section.

Wing vertical bending loads are carried by the main spar and top and bottom skin stringer panels and are transmitted to the fuselage by the main spar fittings. Vertical shear and torsion loads are carried by the torsion boxes formed by the spars and skin panels and transmitted to the fuselage through the main spar fitting. Drag shear moment is transmitted to the fuselage through the front and rear spar fittings.

Single-slotted flaps, maximum deflection 40 deg., extend from the inboard end of the aileron to the fuselage. Flaps are attached to the wing by three hinges, and actuated at the central hinge. Mechanical interconnection ensures synchronized deflection.

The tail group consists of a one-piece horizontal stabilizer, a two-piece elevator, vertical fin and rudder. Stabilizer is of stressed-skin box design comprising a forward and aft shear web, a center shear web in the inboard section, chemically milled skins and close spaced ribs. Spar caps consist of double light alloy angles, reinforced by aluminum alloy straps toward the root ends. Stabilizer is attached to the top of the fin by a two-bolt fitting on the center spar and a single bolt fitting at the center of the front spar.

Spin Tests

Initial Canadair design had horizontal stabilizer and elevators in normal position, but wind tunnel tests showed the airplane wouldn't spin. Moving the stabilizer midway up the vertical fin did produce a spin, but an inconsistent one. The company then chopped off the top of the cruciform, leaving the horizontal tail high, but this reduced directional stability. In the final configuration, in which the chord of the vertical fin was increased, tunnel tests indicated good directional stability and good consistent spin characteristics, AVIATION WEEK was told.

CL-41 elevator sections are all-metal, with a single spar and full-depth metal honeycomb sandwich material aft of the spar, reinforced by chordwise ribs near the hinge points. Elevator sections are interconnected by a torque tube and attached to the stabilizer by two hinges on each side. Elevator control movement is 25 deg. up, 13 deg. down. Balance tab and trim tab both move 10 deg. up, 30 deg. down.

The all-metal fin is of two-spar design with chordwise ribs, built in permanently to the rear fuselage. Rear spar caps are of multiple construction. Leading edge is attached to the fin box at the front spar; a portion is detachable for access to elevator controls. Two hinges provide for rudder attachment.

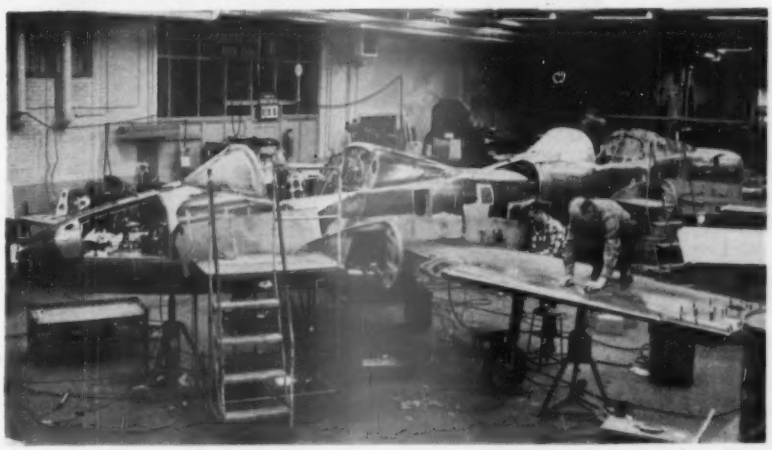
Rudder Construction

Rudder is of aluminum alloy construction with a single spar, stiffened panels and chordwise ribs. Rudder movement is 30 deg., left and right. A ground-adjustable tab is provided on rudder trailing-edge lower section, within easy reach of ground personnel.

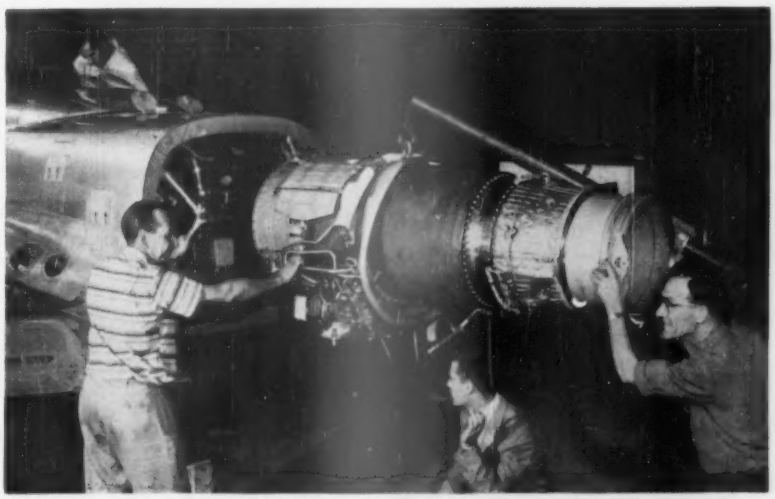
Landing gear also is similar to that of the Cessna T-37, with nose wheel derived from a design of Jarry Hydraulics, Montreal, for the Avro CF-105 (a combination nose wheel steering and shimmy dampener), but miniaturized. Main gear retracts inboard into the wing between the main and rear spars. Nose wheel retracts forward into the fuselage nose section.

Each main gear consists of an upper drag brace and cylinder assembly and a lower piston and axle assembly which carry vertical and drag loads. Nose gear consists of an upper drag brace and cylinder assembly; lower piston and fork assembly carries vertical and side loads. Torque links prevent relative rotation of the shock strut barrels except through the steering mechanism. The nose wheel rotates, with rudder pedal pressure, up to 45 deg. from neutral, corresponding to a turning circle of 37-ft. diameter.

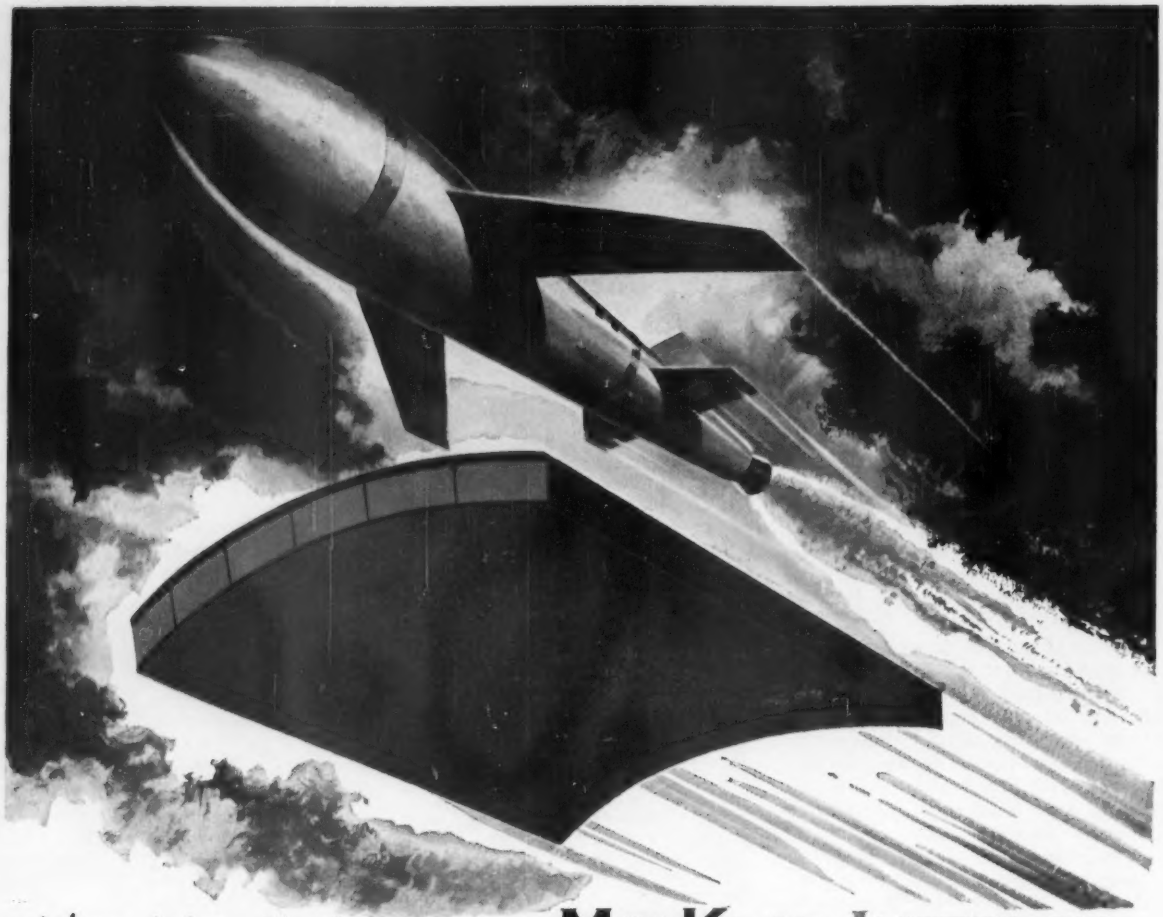
The airplane is equipped with dual controls. Primary flight control systems



PRODUCTION view shows two CL-41 prototypes in varying stages of construction. Note large-size inspection panels and radio access door in nose section.



TECHNICIANS install Pratt & Whitney JTC12A-2 turbojet engine. Plane can also use Armstrong Siddeley Viper, General Electric J85 and Rolls-Royce RB.145 engines.

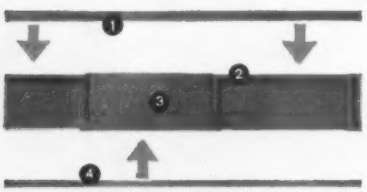


Johns-Manville Announces... MIN-KLAD INTERLOK

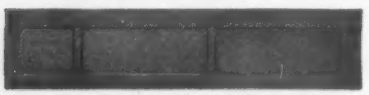
. . . a new structural system interlocking Min-K insulation and high-temperature reinforced plastic

Missile experience shows that in certain heat control situations no one material will perform as well as two (or more)—*an insulation with protective high-temperature facings.*

Problem is how to effectively combine these materials into a structurally strong unit? The answer is Min-Klad Interlok



1) Outer facing, 2) Interlocking web, 3) Core, any one of several Min-K formulations, and 4) Inner facing.



All the above components combine to provide a custom-made structural strong insulating system.

—a new structural system that interlocks Min-K insulation and reinforced plastic, metal or other high-temperature facings.

The result: one product that gives the missile designer every advantage of high-temperature plastic or metal foil—strength, toughness, rigidity! Erosion resistance! High heat capacity!

. . . plus the outstanding advantages of Min-K insulation—an insulating core that has the lowest thermal conductivity available for service temperatures up to 2000°F steady-state, and higher for transients. Min-K's thermal conductivity is actually lower than the molecular conductivity of still air.

Wide range of facings

For the hot face, the missile designer can specify Min-Klad Interlok in a wide variety of heat-resistant and/or ablating materials—asbestos-phenolic (ARP-40), and similar reinforced plastics, as well as stainless steel and other heat-resistant metal foils and meshes. For some requirements, the cool face can be made of a different material—for example, one that offers characteristics required for bonding or fastening to other surfaces and parts.

Like all J-M Aviation insulations, Min-Klad Interlok is factory-fabricated to your specifications into external skin panels, heat shields, cylindrical liners or component housings of any shape or size. Write today for technical specifications. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JOHNS-MANVILLE JM PRODUCTS

are push-pull or torque tube type. Control sticks are fitted with USAF B8-A type hand grips, incorporating trim and nose-wheel steering operating switches. Pedals are adjustable, with 7-in. travel.

The single turbojet engine is installed in the fuselage center section, aft of the wing main attachment structure. Left and right hand engine air intake duct, with air entry forward of the wing root leading edge, passes into the fuselage immediately aft of the cockpit rear pressure bulkhead and join to form a single air intake duct immediately forward of the engine. The tailpipe is contained within the rear fuselage section.

Engine Supports

The engine is supported at the main trunnions by a tripod structure attached to the main fuselage frames. An auxiliary vertical support is provided near the engine intake face. Mounting provides for angular and fore and aft adjustment. Firewalls isolate engine compressor and accessories section from the fuel tank compartment and from the hot section of the engine.

Five rubberized fabric "crash resistant" fuel cells, interconnected to provide single tank operation, hold a total of 270 gal. of fuel. One cell is installed in the fuselage immediately aft of the cockpit rear pressure bulkhead; two are installed in the fuselage between the wing front spar and the main spar frames; two are installed, one at each side of the fuselage, immediately behind the wing main spar frame. The collector tank sits in the lower section of the fuselage between the center cells. One "negative g" boost pump ensures uninterrupted fuel flow, including inverted flight for a period of not less than 15 sec.

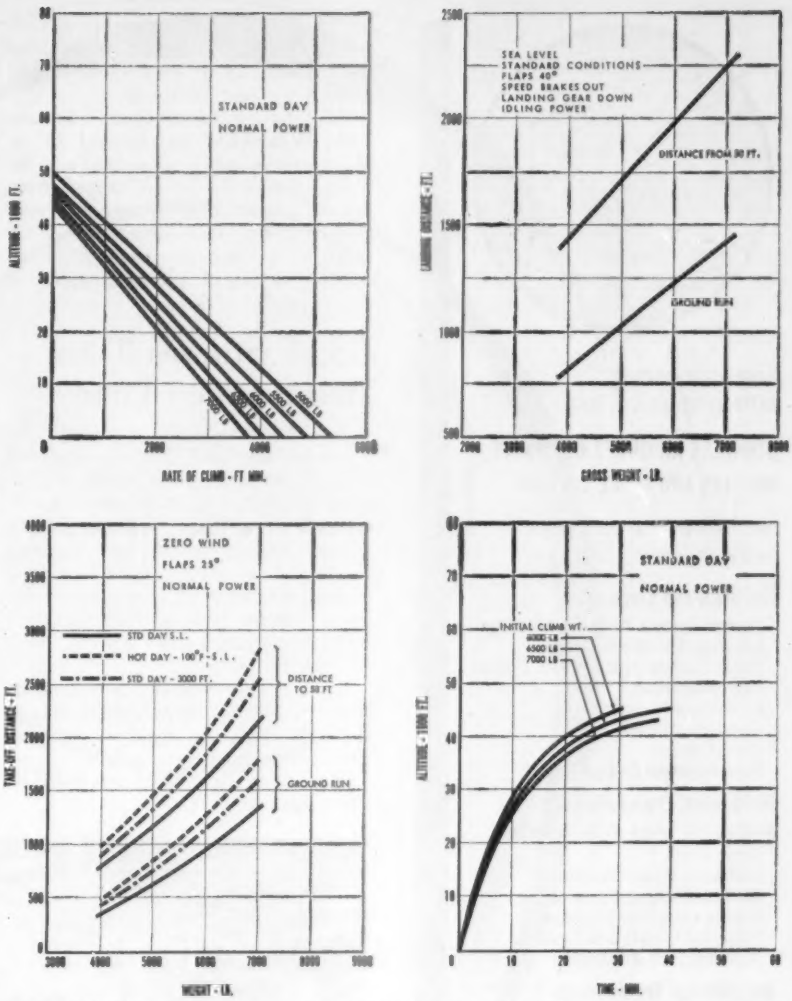
Refueling is accomplished from the wing walkway without the use of a ground stand. Flush type gravity filler assembly, with provisions for draining off spilled fuel, is provided on the left-hand side of the CL-41, about 2 ft. aft of the cockpit. The system accepts a minimum refueling rate of 60 gal. per min.

Flight Instruments

Flight instruments provided with the CL-41A include gyro-magnetic heading indicator (with ADF and Tacan pointers); Tacan distance measuring indicator; altimeter, airspeed, attitude, rate of climb, turn and bank indicators; accelerometer, Machmeter and clock. Dual instrument includes the heading indicator, and altimeter, airspeed, attitude, rate of climb and turn and bank indicators.

The CL-41 uses a closed-circuit constant pressure hydraulic system with a nominal operating pressure of 1,500 psi.

The system operates these subsystems: landing gear and doors, wing flaps, speed brakes, intake screens, nose-wheel steering. An independent unboosted system operates the wheel brakes.



PERFORMANCE charts detail rate of climb (top left); landing distances (top right); takeoff distances (lower left) and time to climb (lower right).

The airplane is equipped with a 28-v.d.c. and a 115-v. 400-cycle a.c. electrical system. Primary power system comprises a main bus, powered by the generator or a ground energizer, a battery bus powered by the battery (24-v., 36 amp.-hr.), and an emergency bus powered either by generator or ground energizer normally and by battery under emergency conditions.

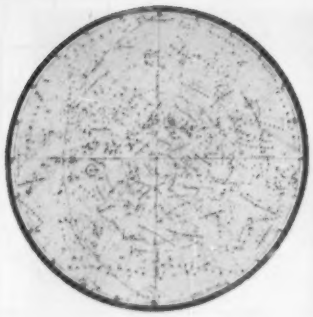
Two 250-watt fixed landing lights are installed in transparent portions of the wing leading edge. One 150-watt fixed taxi light is installed in the fuselage nose. An amber 32-candlepower light sits in the transparent nose cone, indicating to a ground observer when the landing gear is down and locked. External power receptacle is installed on the right side of aircraft, above the trailing edge section of the wing. Cockpit seats are adjustable over a 5-in. vertical range and are designed for back-type parachutes.

Cockpit air conditioning system is supplied by air from the engine compressor. A turbofan cooling unit is positioned in the forward part of the first engine zone.

Cooling System

Bleed air is cooled by an expansion turbine and via ambient air drawn through a heat exchanger by the fan portion of the cooling unit. Cockpit temperature is limited to a maximum of 200F (93C). Ram air outlets provide unpressurized ventilation air in event of air-conditioning system malfunction.

Cockpit is not pressurized from sea level to 8,000 ft. Beyond this altitude cockpit pressure is maintained until a maximum cockpit to ambient differential pressure of 3 psi. shall be reached, which is maintained to a service ceil-



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ing of 44,500 ft. Air pressure is controlled through a pressure regulator and limited by a relief valve in the forward pressure bulkhead.

Pitot-static system is electrically anti-iced. Windshield and forward 18 in. of the canopy can be de-misted and defrosted internally by air tapped from the air conditioning system and controlled to a temperature of 250F (121C). A manually operated switch controls supply of anti-icing warm air to the engine air intake.

USAF Studies T-38 Maintenance Time

Los Angeles—Study by U.S. Air Force has disclosed that the Northrop T-38 Talon supersonic trainer will require less than 14½ hr. of maintenance for each flying hour, Northrop Corp.'s Norair Division reports. Air Training Command is scheduling 14.3 maintenance hours per flying hour, and the figure is expected to diminish further once ATC maintenance crews become familiar with the airplane.

In view of this study, Northrop expects its N-156F fighter, sister ship to the Talon, to have maintenance time close to the predicted 21.5 hr.

The maintenance study was based on three factors:

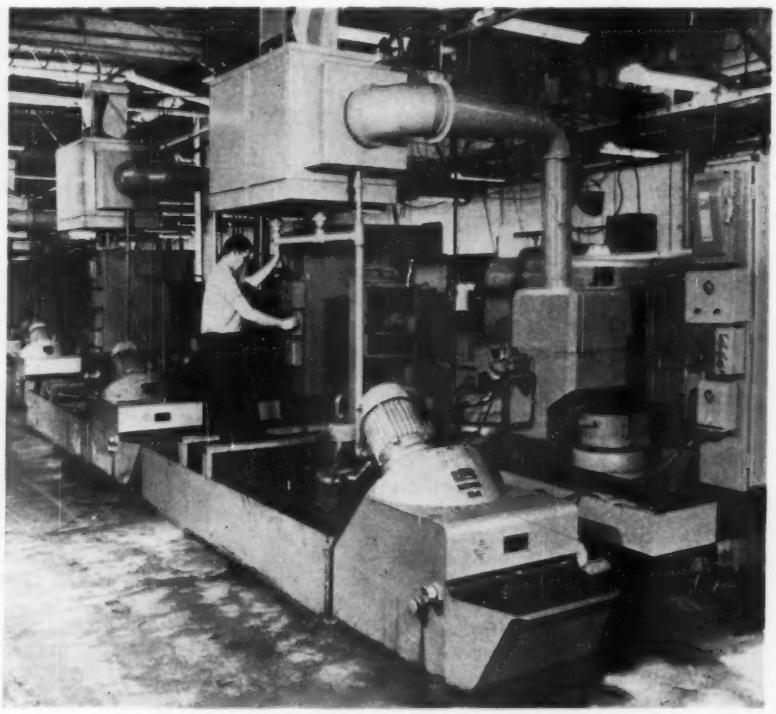
- **Experience** with the Lockheed T-33 trainer.
- **Familiarity** with twin-engined aircraft
- **Experience** in introduction of new aircraft in existing squadrons.

ATC program scheduled 60 flying hours per month for each Talon. Comparison between T-38 and T-33 performance shows that the Talon requires approximately 3½ hr. more maintenance than the single-engined T-33.

Northrop presently is conducting a flight test program at Edwards AFB, Calif., with the T-38 and has logged about 100 hr. since airplane's first flight. The N-156 is undergoing a simultaneous flight test program at Edwards.

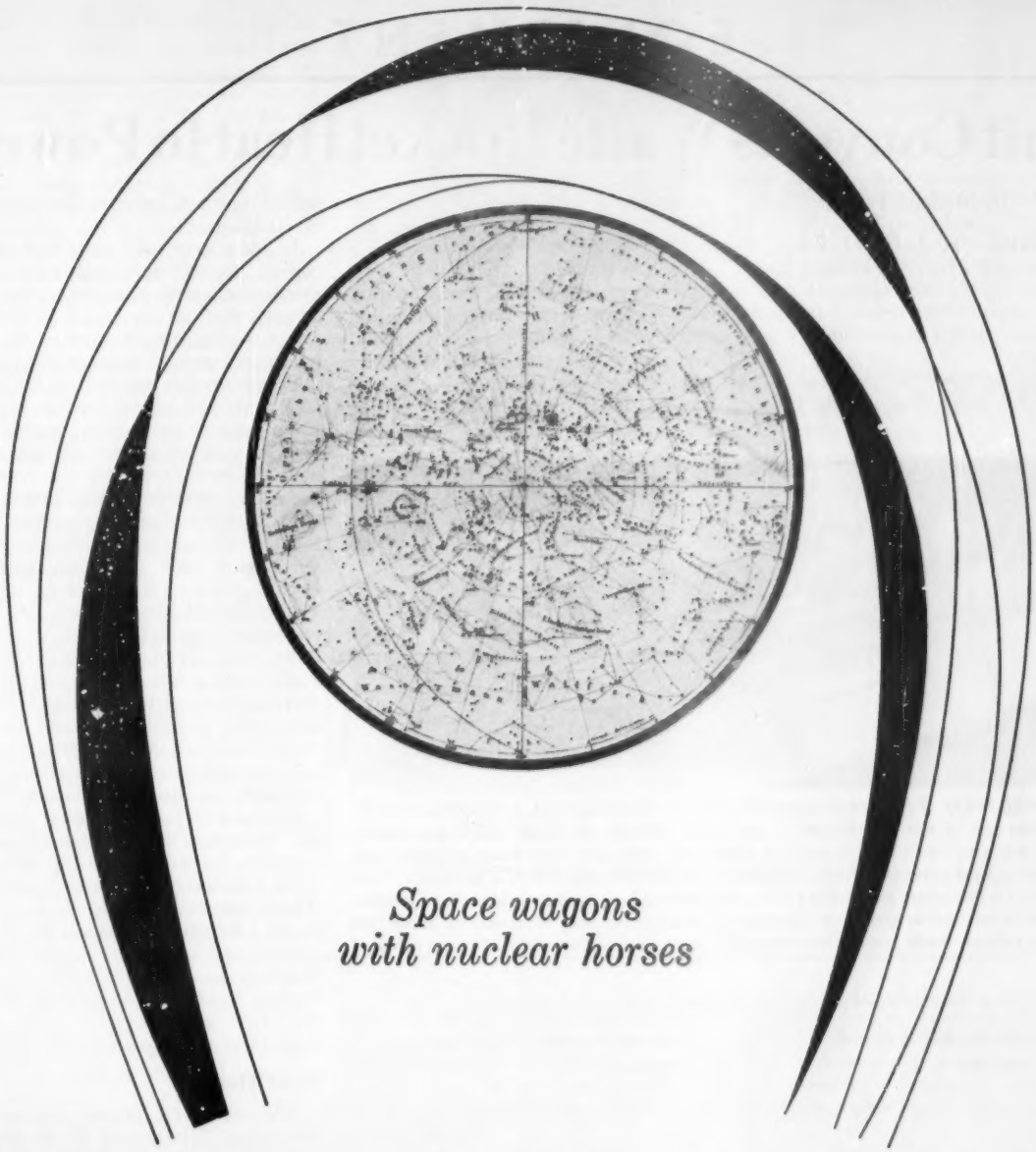
P&W Orders Blade Moment Balances

Dynametrics Corp. of Burlington, Mass., will design, develop and manufacture four blade moment balances for Pratt & Whitney Division of United Aircraft Corp. under a $55,000 contract. Instruments will be used to evaluate jet engine turbine blades. As each jet engine turbine blade is inserted into a blade-holding fixture, the instrument sets an automatic counter corresponding to the measured moment and stamps an appropriate code on the blade.



Lycoming Installs Coolant Clarifier

High capacity centrifugal coolant clarifier for use in grinding turbine blades for turbojet engines has been installed at Avco Corp.'s Lycoming Division, Poughkeepsie, N. Y. Clarifier is built by De Laval Separator Co. and is called "Turbomatic." Major advantage, Lycoming says, is in elimination of scratches from abrasives in coolant.



Space wagons with nuclear horses

Space exploration will really come of age when manned rockets can leave earth, accomplish their missions and return without disposing of parts of themselves en route. This breakthrough depends on the rapid development of both nuclear rocket engines and space vehicles capable of using them. Douglas is putting forth a major research effort in the area of manned nuclear space ships. Every environmental, propulsion, guidance and structural problem is being thoroughly explored. Results are so promising that even if the nuclear engine breakthrough comes within the next five years, Douglas will be ready to produce the vehicles to utilize this tremendous new source of space power! Douglas is seeking qualified scientists and engineers for this and other vital programs. Some of our immediate needs are listed in the column on the facing page.

Elmer Wheaton, Engineering Vice President, Missiles and Space Systems, goes over new space objectives that will be made possible by nuclear propulsion with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

Unit Converts Waste Rocket Heat to Power

By Michael Yaffee

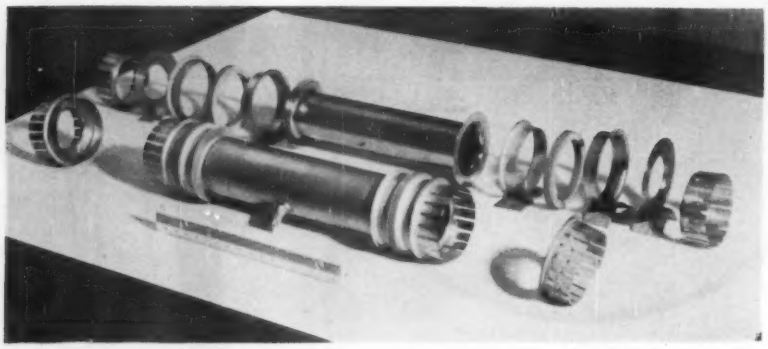
Princeton, N. J.—Radio Corp. of America and Thiokol Chemical Corp. have developed a new thermionic auxiliary power unit which converts the waste heat from a rocket exhaust directly into electricity.

Initial units will be designed to fit around the flame tube or into the expansion cone of large solid propellant missiles such as the Eagle, Subroc, Polaris or Minuteman. Purpose of the units will be to provide short bursts of large amounts of electricity that can be used to power the control fins or moveable nozzles as well as the missile's electronic equipment. It is estimated that a series of the new units placed on just one of the nozzles in the Minuteman ICBM second stage will have a design potential of 30 kilowatts.

In addition to solid propellant rocket engines, the new units, which are called thermionic energy converters, can be adapted for use on liquid propellant rocket engines, ramjets, and on the afterburner portion of turbojet engines.

For continuous operation in satellites, later units will be designed to operate using solar, or more likely, nuclear energy in place of short-lived rocket exhausts. Theoretically, the new units are capable of producing more than 1,000 watts of electrical power per square centimeter with an efficiency of 64%. With the present units, RCA scientists believe that they will be able to achieve a capability of 250 watts/sq. cm. with efficiencies approaching 35%.

RCA and Thiokol engineers say they could have a full scale model of the thermionic converter ready for flight on large solid propellant missiles in two years. So far, RCA has built only small experimental units to demonstrate their feasibility. In this work, which has been carried out at the companies' expense, the converters, in the form of hollow cylinders, fit over the flame tubes of small, end-burning (for longer duration), Thiokol test engines. In its own tests at its Lancaster laboratory, RCA uses an electrical heat source in place of the rocket engine. Of the first 10 units, nine worked, and the RCA scientists say that they have obtained up to 270 watts from these laboratory models.



EXPLODED VIEW of thermionic converter shows, in the foreground, a complete converter with extra pair of fins and, behind it, the anode (cathode fits inside and is not visible). Second ring from each end of anode is aluminum oxide insulator. Rings on either side of insulator have same coefficient of expansion as insulator and attach it to anode. Next to last unit is disk which is attached to fins after they are bent back to form cable connectors. Exhaust tubulation in center of converter is attached to hole in center of anode and leads to inter-electrode gap. After vacuum is drawn and cesium injected, tube is sealed.

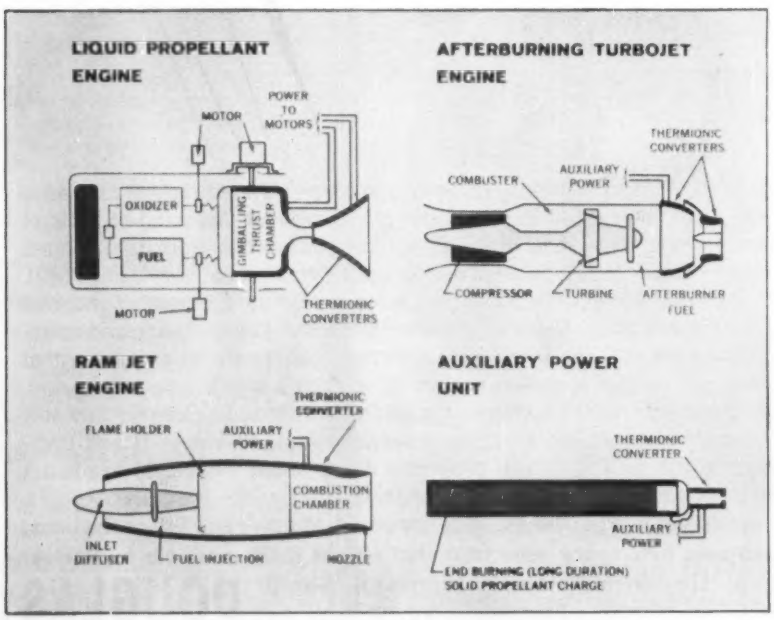


CHART illustrates some possible applications of new thermionic APU. Not shown are long duration thermionic converters operating on heat from nuclear or solar sources.

Next Step

The next step, as now planned by RCA and Thiokol, will be to develop thermionic converters that can be built into the expansion cones of large solid propellant engines. This will require more money than the initial development, and the companies hope to have one of the government's missile or space agencies underwrite this phase of the work, which is expected to cover a two-year period.

To date, the two companies have made joint proposals to Wright Air Development Center, Ballistic Missile Division, Space Technology Laboratories, Advanced Research Projects Agency, Army Ballistic Missile Agency and the National Aeronautics and Space Administration. Generally, the proposals have been received with interest, the companies report. If a government contract does materialize, it will probably not be before next year.

According to the proposal, Hunter-

Bristol Division of Thiokol would be the prime contractor and would be responsible for program management, application, design integration and nozzle fabrication; Electron Tube Division of RCA would be subcontractor to Hunter-Bristol and would perform thermionic energy converter studies, design and fabrication; Thiokol's Elkton Division would also be subcontractor to Hunter-Bristol and would provide test facilities, engine cases and propellant; RCA's David Sarnoff Research Center would be subcontractor to the Electron Tube Division on a cathode and anode materials study; and Battelle Memorial Institute, which would also be subcontractor to RCA's Electron Tube Division, would carry out gas permeability studies on possible cathode materials.

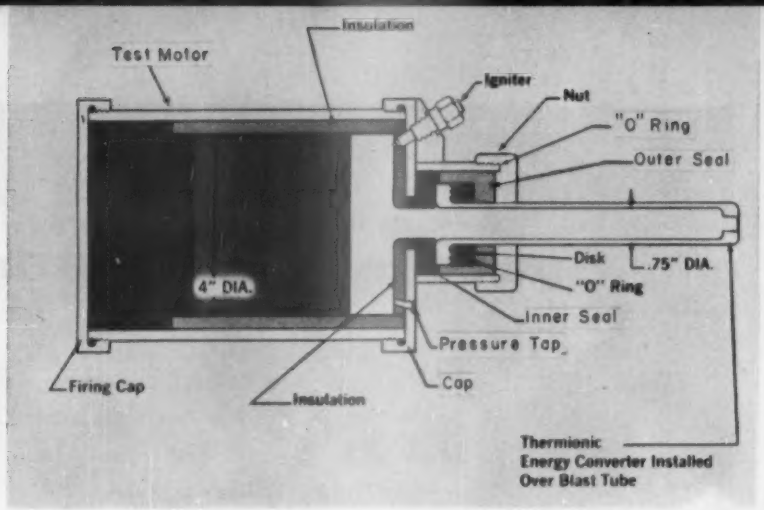


DIAGRAM of thermionic converter installed on flame tube of small solid propellant test engine shows all main components and how they fit together.

Converter Characteristics

As indicated in the proposal, there are a number of problems that have to be solved before the first, large thermionic energy converter becomes an operational reality. But the device does possess many characteristics which are almost sure to attract the weight, reliability and cost-conscious missile engineer. Chief among these are the following:

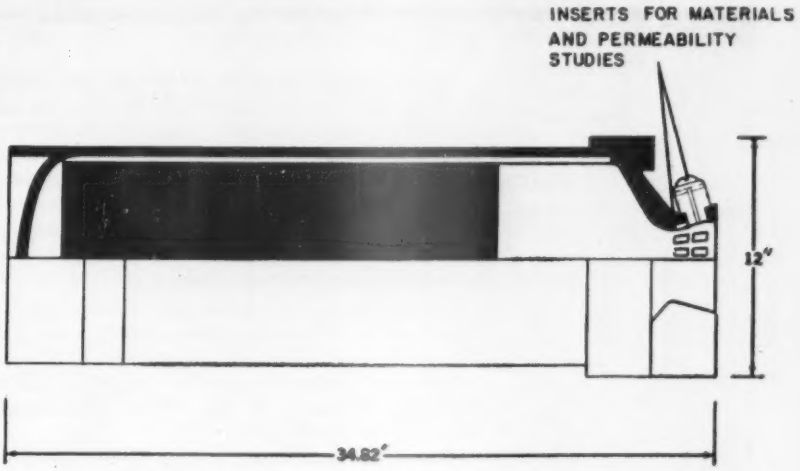
• **Simplicity.** The converter has no moving parts. Basically, it consists of a cathode plate and an anode plate with a gas sealed between them and two wires to complete the electrical circuit.

• **Lightweight.** The laboratory model that produced 270 watts of electrical power weighed only 3½ lb. RCA scientists believe they will eventually attain 150-175 watts/lb. Not only will the device replace comparatively heavy chemical batteries or other self-powered auxiliary units, but the cathode of the converter will become part of the nozzle wall and so replace an equal area of nozzle material.

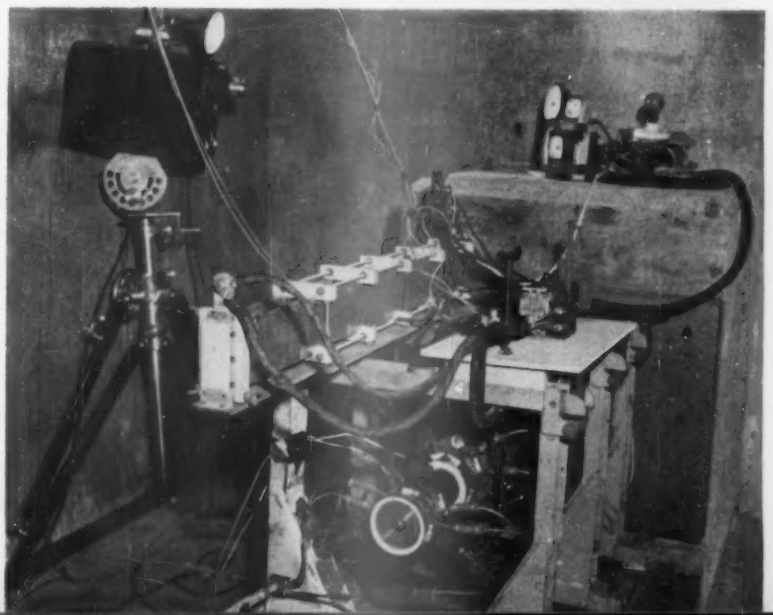
• **Waste heat operation.** The converter, according to RCA and Thiokol engineers, operates on waste heat and does not draw off useful power from the rocket that would go into producing thrust. In this way, the device also helps to remove some of the heat from the nozzle itself.

• **Large power potential.** RCA and Thiokol consider a power capability of 40 watts/sq. in. and a conversion efficiency of 35% as being "presently achievable." The only limit to power generation, they say, is the amount of usable surface area available on the vehicle.

• **Low cost.** Thermionic power generation is expected to cost less than $1/watt compared with an estimated $1,200/watt for solar cells. (For a more realistic cost comparison, of course, it would be necessary to figure in the solar collectors or the nuclear reactors required to turn the thermionic converter into a



THIOKOL and RCA steps in the proposed development program include plans to develop designs and materials for converters that can be built right into the expansion cones of solid propellant engines (above). Actual test set-up (below), in Thiokol's Elkton laboratory shows thermionic converter in place on flame tube of end-burning solid propellant motor. Converter is covered with black argon-filled shroud to reduce high temperature oxidation. Lines coming off shroud are argon lines and electrical leads to load bar and to thermocouple measuring devices.



Space Age Milestone!

Man's flight into outer space drew nearer on September 11, 1959 with the successful re-entry of NASA's "Big Joe" test capsule controlled by a Honeywell Stabilization System

The guidance system for this capsule, launched by an Atlas missile, was provided by Honeywell—and it was delivered in less than half the time usually required for projects of this scope.

Rapid delivery was possible because the basic components necessary to accomplish this sensitive and exacting task were on-the-shelf or in production at Honeywell. However, two critical jobs remained to be done. One was the task of designing a package for these components which would be rugged and exact enough to do the job; and the other was that of providing the ground support for system check-out and pre-launch monitoring. Both of these difficult objectives were completed in the time allowed.

This electronic stabilization and control system is designed to provide a reference that permits measurement of the capsule's attitude and rate of motion. By operating the on-off valves for the reaction control nozzles, it dampens any oscillatory tendencies of the capsule and eliminates the possibility of tumbling.

The design and delivery of this system, the first of six such Honeywell systems for NASA Mercury capsule test shots, is in keeping with the accelerated man-in-space program and is typical of Honeywell's ability to meet both stringent requirements and critical deadlines.

Final check of attitude stabilization control system for flight and re-entry control of "Big Joe" test capsule is made by a Minneapolis-Honeywell technician prior to delivery.

This readiness for the space age stems both from Honeywell's established policy of supporting the national defense and from the company's own historic areas of interest. For further information concerning Honeywell's capability in space age projects, write Minneapolis-Honeywell, Aeronautical Division, Dept. 671, 2600 Ridgeway Road, Minneapolis 13, Minn.

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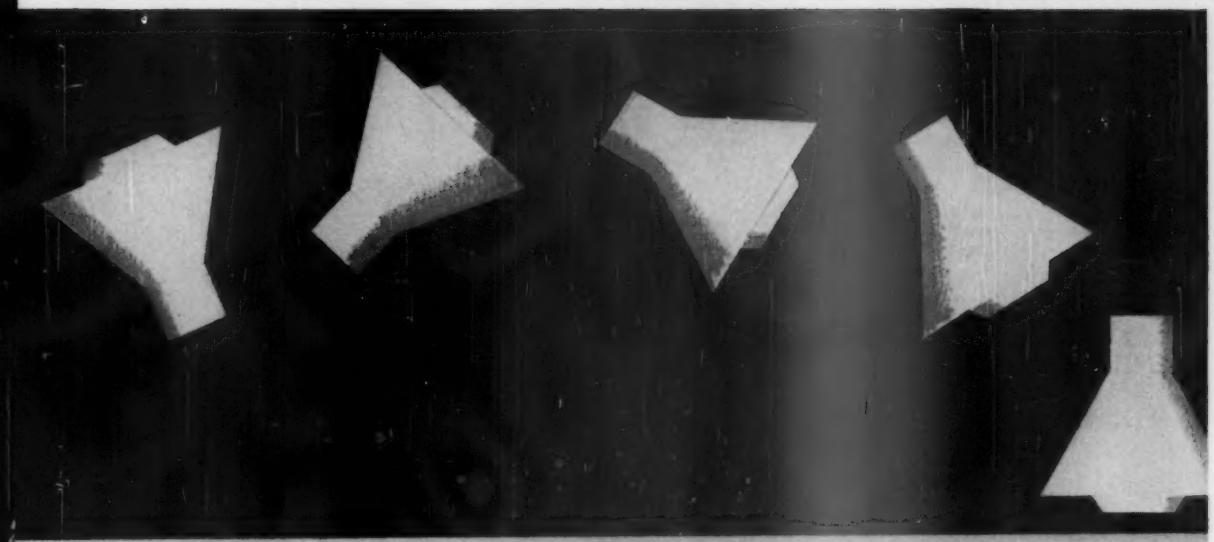
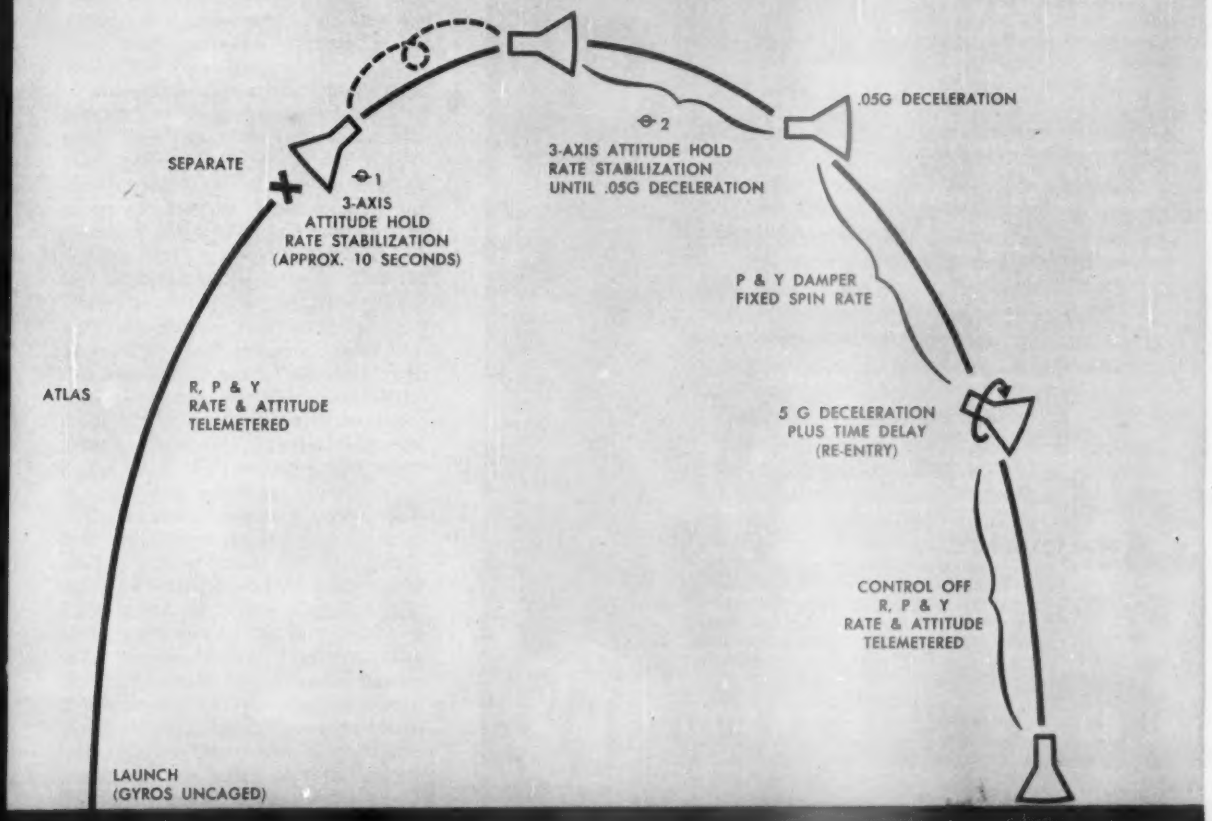
H Military Products Group



The Honeywell "Big Joe" Control System assumes control at separation and immediately provides a three-axis attitude hold, rate-stabilized mode to maintain the separation attitude (Θ_1). Approximately ten seconds later, it programs the capsule to a new attitude (Θ_2), and maintains this attitude until .05g deceleration is sensed, indicating that re-entry is commencing. Upon sensing .05g deceleration, attitude hold shuts off, pitch and yaw rate stabilization are maintained, and the capsule is commanded to spin at a 6°-per-second rate until deceleration increases to 5g. At this point control ceases. With attitude reference control deleted, the blunt end of the capsule slowly turns into the flight path due to its aerodynamic static stability. The rate gyro control dampens any tendency to tumble, yet permits the capsule orientation to move as required to keep the heat-resistant blunt end leading. Pitch, roll and yaw attitude, as well as rate signals, are telemetered from takeoff to touchdown.



THEY RELY ON RADIATION

for "Courier" communications antenna systems

Advanced Research Project Agency's communications satellite "Courier" will soon be placed into orbit.

This communications satellite will transmit and receive up to twenty 100-word teletypewriter messages per minute between one or more ground stations. "Courier" is regarded as a major step toward true universal communications for television, radio, telephone, telegrams, mail, and other media.

Radiation was selected to develop, build and install the ground-based antenna systems. Engineering and technical direction are under the cognizance of the Army Signal Research & Development Laboratory (IT&T and Philco are the other prime electronic contractors for the Project).

These communications antennas, capable of simultaneously transmitting and receiving messages, will be similar to Radiation's 60-foot "big dish" antennas now spanning half the world.

RADIATION IS a leader in space electronics. Among current projects are assignments on "Courier", "Minuteman", "Tactical Air-to-Surface Missile Study", and "Discoverer".

If you'd like more information on Radiation, write for the latest capability report. Address: Radiation, Inc., Dept. AW11, Melbourne, Fla.

Radiation's plants are at Melbourne and Orlando, Florida; Mountain View and Palo Alto, California.

RADIATION INCORPORATED

COMPLETE thermionic energy converter, developed by RCA and Thiokol, fits over flame tube of solid propellant rocket engine and converts waste heat from exhaust directly into electricity.

continuous, long duration electrical generator comparable to the solar cells.)

• **Flexibility.** Theoretically, the new thermionic converter can be used with any high temperature source including solid propellant rockets, liquid propellant rockets, ramjets, turbojet afterburners, ground or airborne nuclear reactors, and solar energy. The unit also could be used in conjunction with General Electric's new magnetohydrodynamic power generator to produce the large magnetic field required by the latter (AW Nov. 16, p. 133).

Thermionic converters are not new, but until recently they have been little more than laboratory curiosities. Missiles provide much of the impetus for transforming these devices into actual pieces of hardware. Until recently, the efficiency of thermionic devices in converting heat into electricity was too low to be of much interest. But the efficiency goes up almost exponentially with temperature, and rocket engines provided the high temperatures and excess amounts of heats that could make these converters practical. Rockets also provided the necessity which mothered their development. As missiles become bigger and faster, it requires more power to move their vectoring controls.

Conventional auxiliary power units that could move the nozzles of a large solid propellant missile like the Minuteman, for example, would probably be fairly large and heavy. Too, the large metal inclusions in the new solid propellants makes the use of turbogenerator devices unsatisfactory. Thiokol wanted a new source of auxiliary power that would have a better power-to-weight ratio than present APU's, preferably something new rather than just an improved version of existing units.

In its search, Thiokol came across the work that Dr. Karl G. Hernqvist

The bat's keen hearing enables it to pick up sounds beyond the range of the human ear. The high pitched cries it continuously emits are reflected by obstacles and guide the bat in its flight path.
False Vampire (Lavia Frons)
MILLENNIUMS of DESIGN DEVELOPMENT
Here's an antenna that's survived severe environmental testing through several thousands of years. Design factors, if we can believe Darwin, were purely empirical.
Dorne and Margolin has designed hundreds of specialized antennas for every major aircraft manufacturer in the country. With less time at our disposal than the bat, we've had to evolve ingenious solutions to antenna design problems. We've never failed an assignment.
If you have a problem involving antennas, it's more than likely that our background of design and production experience can provide a speedy, economical solution.
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Excellent positions in a growing organization affording opportunities for stock participation, as well as many other benefits, are offered to engineers. Contact R. W. Navis, Personnel Director.
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Grumman Gulfstreams undergoing a custom tailored completion program at the AiResearch Aviation Service Company facility.

THE GARRETT CORPORATION

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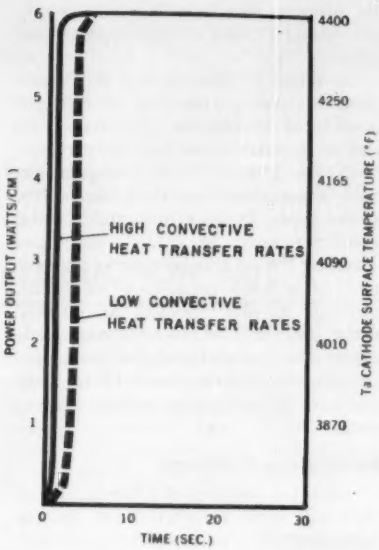


POWER output vs. time is calculated for two thermionic converters with tantalum cathodes placed in different positions on an expansion cone, the one with the higher heat transfer rate being closer to the nozzle. Chart is actually a cross plot of two curves, power output vs. cathode temperature and time vs. cathode temperature, in which temperature factor cancels out.

and his colleagues at RCA had been doing on thermionic energy converters. Dr. Hernqvist had already managed to improve the efficiency of the device somewhat by using cesium vapor to reduce space charge effects in the inter-electrode gap.

Basically, a thermionic energy converter is a very simple device consisting of a cathode and anode separated by a vacuum and connected by a cable that travels through a load device where the electricity is taken off to perform useful work. Heat applied to the cathode frees electrons which travel through the vacuum to the anode, out through the load device and back to the cathode.

Negative Charge

In a vacuum, however, the electrons, as they move from cathode to anode, build up a collective negative charge which repels the new electrons coming off the cathode and thereby limits the amount of current flow. To reduce this effect, RCA injects cesium into the inter-electrode vacuum (in a nuclear rocket, the natural gamma radiation could be used for the same purpose). When a cesium atom strikes the hot cathode, it loses an electron and becomes a positive ion, combining with the inter-electrode electrons to form, in effect, a neutral plasma which has high electrical conductivity and no space charge effects.

Some of the cesium also condenses on the relatively cold anode and reduces its work function, the amount of energy required to remove—or by which the electrode material holds—an electron. This is beneficial, because the greater the difference between the work functions of the cathode and anode, the more efficient the converter.

The thermionic converters developed by RCA and Thiokol are hollow cylinders, 12 in. long and 1.75 in. in diameter. The anode is nickel-plated copper which can be adequately cooled, at least for the short periods of a solid propellant rocket operation, by convection (air cooling) or storage (heat sink). The cathode is molybdenum with a tantalum sleeve to improve emission of electrons. The space between the two electrodes is not critical because it is filled with cesium but runs about .04 in.

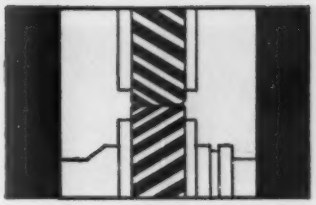
To date, RCA has actually measured conversion efficiencies of only up to 10.4%. This was on an experimental thermionic tube which had a tungsten ribbon cathode, and the 10.4% was achieved at a temperature of 2,910K. With their present molybdenum-copper converter, Thiokol and RCA are getting efficiencies of approximately 8% at 2473K. (In a rocket, conversion efficiency, which takes into account radiation heat loss from the cathode, is not as important as it would be in a ground-based power station because of the excess heat available from the rocket exhaust. More important for missile and space applications, says Dr. Hernqvist, is the power-to-weight ratio.)

Cathode Improvement

At the present time, RCA is working on ways to raise this efficiency through improvement in cathode and anode materials. Theoretical calculations show a potential conversion efficiency of 38.6% for a tungsten cathode operating at 3,400K. With a tantalum cathode instead of a tungsten one, says Dr. Hernqvist, it is possible to do even better. Theoretically, RCA and Thiokol scientists say cathode materials could be developed that would give a converter efficiency up to 64% for short periods.

However, at 3,400%, tungsten evaporates at the rate of 66.6 mm./hr. and tantalum, even faster. This presents a problem as far as the long duration operation that would be required of a converter in a satellite but not an insurmountable one, according to Dr. Hernqvist. For one thing, he says, tantalum can perform as well or better than tungsten at lower temperatures.

This is only one of the problems that has to be solved. At high temperatures, tungsten and the other refractory metals are easily permeated by hydrogen which could put the thermionic converters out of action. This is



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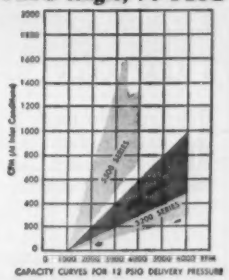

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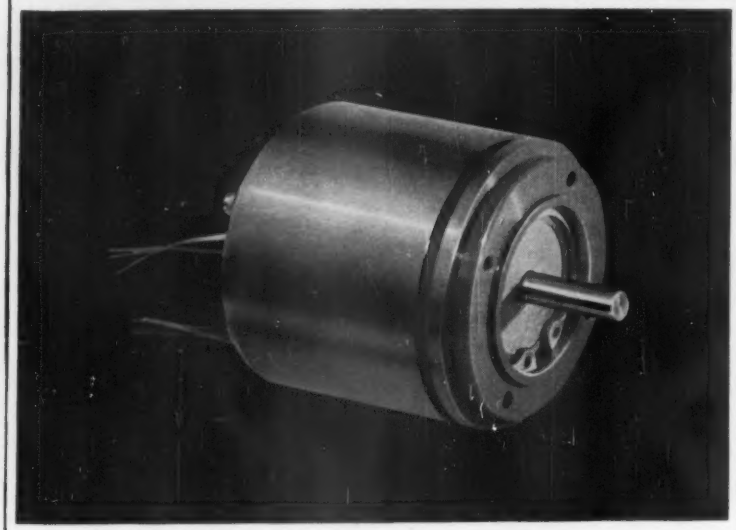
ENGINEERING
REPORT
ON BENDIX COMPONENTS



ONE-MINUTE SYNCHRO SYSTEM ACCURACY

Electrical two-speed Autosyn* synchro features—

- ACCURACY UNAFFECTED BY THERMAL AND MECHANICAL STRESS
- HIGH SIGNAL-TO-NULL RATIO
- ELIMINATION OF GEAR ERROR FOUND IN MECHANICAL TWO-SPEED SYSTEM
- ADAPTABILITY TO GYRO PICKOFF

Developed to meet need for accurate data transmission with maximum system simplicity. Produces two electrical outputs from single shaft, thereby eliminating inaccuracies of two-speed gear system as well as installation and maintenance costs of additional unit.

The synchro contains two separate sets of windings. One set produces the normal signal pattern of one cycle of output voltage, while the other produces eleven cycles, for each rotation of the synchro shaft. Increase in accuracy is very close to the 11-to-1 theoretical maximum, resulting in a system error of ±1 minute when used back-to-back with similar units.

*REG. U. S. PAT. OFF.

ADDITIONAL CHARACTERISTICS:

Input voltage (to rotor)	26 volts, 400 cycles, single phase
Input current	200 ma max.
Input power	2.5 watts max.
Signal-to-null ratio	350:1
Sensitivity (mv/degree)	3500

For more detailed information on specific applications, write—

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the problem that Battelle would investigate under Phase I of the proposed program.

In Phase I, Thiokol and RCA propose to develop a number of different models of thermionic converters that can be inserted into and become part of the nozzle wall. These configurations will be more realistic than the hollow sleeve types, because the anode of the converter must be cooled; and, says Thiokol, the expansion cone is the best part of a solid propellant rocket for cooling. As now planned, several converter units will be inserted around one expansion cone and probably connected in series to provide the 8-15 hp. output now desired in large auxiliary power units.

Remaining Problems

Among a number of other problems that still must be worked out are the following:

• **Design.** The thermionic energy converters will have to be designed to fit into existing structures.

• **High temperature.** Because the cathode will be exposed to the rocket exhaust, cathode materials will have to be developed and fabricated which have, in addition to good emissivity, good high temperature resistance in an erosive and reducing environment.

• **Ablation.** Cathode materials will have to be found that ablate at the same rate as the surrounding insulating material (generally a reinforced plastic) that lines the rocket nozzle.

• **Electrical modification.** Thermionic energy converters are essentially low voltage, d.c., generators. This is all right for simple, rocket vectoring control power. But the telemetering and other electronic equipment in satellites probably will require alternating current as well as higher voltages and load impedances. While this can be done, it is almost certain to entail additional weight.

• **Satellite adaptation.** For long duration satellite operation, new heat sources will have to be found for the converter. If solar energy is used, collectors and storage units must be added, and the absorption coefficient of the cathode must be taken into consideration. With a nuclear heat source, the principal problem is in developing the reactor itself. Evaporation of cathode materials at the high temperatures involved becomes even more critical (making the cathode thicker, imposes a weight penalty and eventually there would be a volume limit). Some means of cooling the anode will have to be built into the converter or satellite.

While many of these problems may appear formidable, RCA and Thiokol scientists believe that all of them can be solved satisfactorily. Those problems involved in developing a thermi-

onic energy converter that will work in the nozzle of a large solid propellant rocket (that is, Phase I of their proposed development program), they estimate, can be worked out in one-and-a-half to two years. The remaining problems and complete program development would require an additional 2-3 years with maximum effort.

PRODUCTION BRIEFING

Lockheed Aircraft Corp.'s Missile and Space Division, Sunnydale, Calif., will install a 96 in. diameter spin forge machine for the production of missiles and space vehicles. The $500,000 machine tool, measuring 40 ft. high by 32 ft. wide, is produced by the Hufford Division of the Siegler Corp.

Servomechanisms, Inc., Hawthorne, Calif., will produce additional true airspeed computers for the Lockheed P2V under $416,280 follow-on contract. The computer provides the airspeed input to the aircraft's navigational system.

Aerojet-General Corp., Azusa, Calif., will conduct basic research studies of electrically exploded wires and films under contract from the Army's Office of Ordnance Research. The cine-microscopic studies involve ultra high speed photography (1,200,000 frames per second) combined with 25-power microscopes.

Standard Pressed Steel Co., Jenkintown, Pa., is developing beryllium bolts at its exotic metals laboratory. The company says that a 125,000 psi. beryllium bolt would, on a strength-to-weight basis, be equivalent to twice the weight of high strength steel bolts. Development problems include reducing the notch sensitivity of beryllium.

Goodyear Tire and Rubber Co., Akron, Ohio, will supply 500 pillow-type fuel storage tanks for the Army under $1 million contract. The 10,000 gal. rubber coated nylon tanks, measuring 40 x 10 x 4 ft., will be used for fuel storage at domestic and foreign bases.

Ozone Metal Products Corp. has received follow-on contracts for the design, test and production of a nose gear steering and shimmy damper system for the McDonnell F4H-1. Most recent contracts bring Ozone's total on this project to more than $250,000.

Anachrome Corp., an affiliate of Anadite, Inc., has opened a division in Tucson, Ariz., which will produce hard anodizing for electronic and missile companies in the Tucson-Phoenix-Ft. Huachuca area.

Republic Aviation Corp. will supply spare parts for F-84F and RF-84F aircraft under a $700,000 contract awarded by NATO's Maintenance Supply Services Agency, Paris.

Electronic Engineering Co. of California will supply three systems of electronic data handling equipment to National Aeronautics and Space Administration's Wallops Island, Va., station under a $207,000 contract. Systems will convert radar azimuth, elevation and range data from missile tracking radars it into a binary format and record it on magnetic tape. One system will be used with an FPS-16 radar; the others will be used with specially modified NASA radars.

Cook Electric Co. has received a contract estimated at $600,000 from North American Aviation for development, testing, tooling and production of 2 amp. 400 cycle a.c. coil relays for North American's B-70 bomber.

Siegler Corp.'s Hallamore Electronics Division will manufacture electronic checkout systems for the Army Sergeant missile under a $700,000 follow-on contract from Sperry Utah Engineering Laboratory, a division of Sperry Rand Corp.

Hamilton Standard Division, United Aircraft Corp., will produce fuel controls for the Canadian Pratt & Whitney Aircraft PT-6 free-turbine engine. The engine will use Hamilton Standard's JFC-50 control which fits into a space 5 in. in dia. and 10 in. high. The control meters 300 lb. of fuel an hour.

Turbocraft, Inc., Pasadena, Calif., will deliver Model 3000 liquid oxygen transfer pumps to the Australian Department of Supply for use in the ground support system of the Blue Streak long range ballistic missile at the Woomera Test Range, Australia. Blue Streak is being developed by de Havilland Propellers, Ltd.

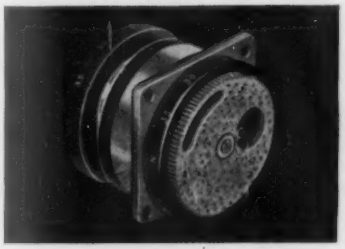
Sites for Nike Hercules installations at Vandenberg AFB, Calif., are under consideration. Final determination of exact locations will not be made until all surveys are completed and approved by the Army. Sites will be located approximately 9 to 12 mi. from area to be defended. Vandenberg defense will be composed of two Nike Hercules batteries.

Douglas Aircraft Co. has received a $58.8 million Navy contract for follow-on production of the A4D-2N Skyhawk light-weight jet attack plane. Previous orders for the A4D-2N have totaled approximately $173 million.

ENGINEERING REPORT ON OTHER BENDIX COMPONENT PACKAGES

CAM COMPENSATOR

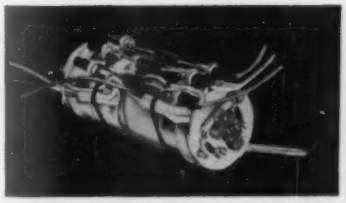
Efficient compensating device for servo system error.



The type CP-20-A1 is a simple, entirely mechanical means of correcting an output data shaft in relation to either servo loop errors, sensing errors, or known environmental factors affecting the system. Eliminates need for adjusting remotely placed or inaccessible units. Ask for full details.

CLUTCHED SYNCHRO

Transmits corrective signal, or establishes new reference.



The type CP-4-A1 is an integrated unit containing a high-precision pygmy Autosyn* synchro and an electro-magnetic clutch. Has general systemic application where it is desired to transmit a corrective signal, or to establish a new reference as a result of a temporary condition. Removal of electro-magnetic clutch excitation instantly re-establishes Autosyn, or signal source, at zero. Three unit-mounted resistors provide for proper output voltage as well as correct phase relationship of output voltage to excitation voltage. Write for further information.

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ENGINEERS WANTED! Challenging projects, unlimited opportunities with Solar. Write today!

FAA Expands Radar Beacon Network

By James A. Fusca

Atlantic City, N. J.—Federal Aviation Agency plans almost complete coverage of the United States by ground installations for its air traffic control radar beacon program within the next 24 months, and complete coverage by 1964, according to a report presented to the Radio Technical Commission for Aeronautics at its annual fall assembly by L. E. Shoemaker, head of the Beacon System Section of FAA's Development Division.

Nine experimental ground facilities have been converted to operational status through this month. These ATC beacon ground installations, sometimes referred to as secondary radars, improve air traffic control by extending the range and altitude coverage of primary ATC radars (AW May 4, p. 126). In contrast with conventional radars which receive energy reflected from the aircraft, the beacon ground installations transmit coded signals which trigger a beacon or transponder in the aircraft which causes it to reply with a coded pulse signal.

Transponder Use

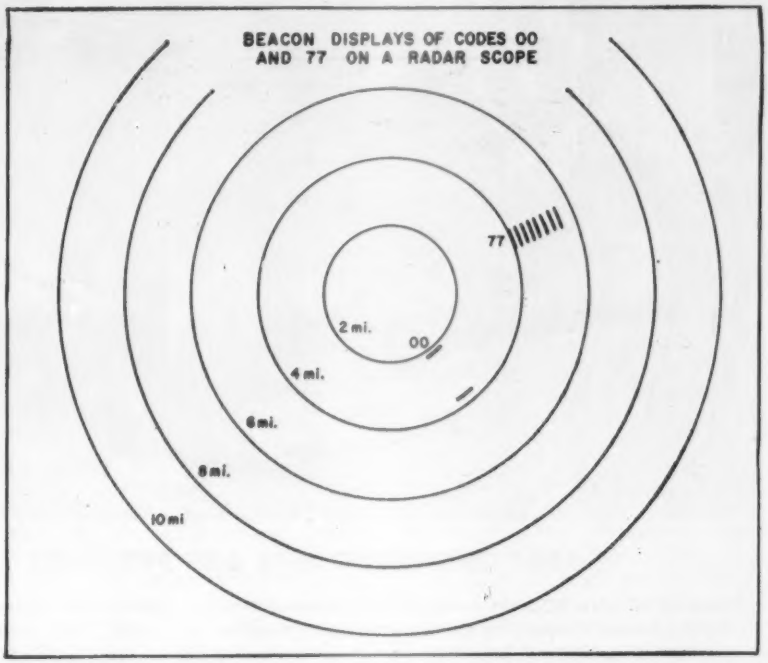
As of this fall, the airlines have approximately 200 transponders in operational use and have placed orders for about 250 more. These will be used primarily to equip new aircraft. Also, provisions are being made for equipping about 300 additional new or retrofit aircraft.

This represents a total of about one-third of the air carrier fleet.

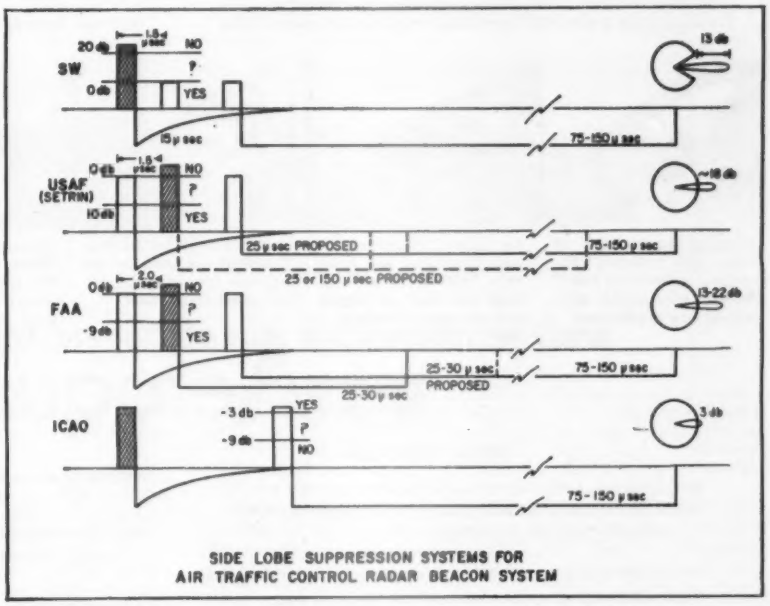
Because the IFF (Identification—Friend or Foe) equipment of military aircraft will respond to interrogation by civil ground installations of the ATC beacon program, military aircraft operating in the Common System for Air Traffic Control are essentially all considered to be beacon equipped.

Three additional development programs being fostered by the FAA are:

- **Lightweight,** minimum cost transponder. This type of unit is required for the private pilot and other non-air carrier aircraft that are capable of IFR flying.
- **Side-lobe and reflection** suppression. Study and selection of one system among the several systems of side-lobe and reflection suppression proposed in this country and the United Kingdom.
- **Storage tube defruiter.** Presently operating equipment for the suppression of unwanted beacon responses (de-



TWO CODES of the possible total of 64 codes available in the joint civil-military mode have been standardized under present plans on a nationwide basis. Code 77 of the octal-numerical system indicates aircraft emergency, and code 00 air defense missions.

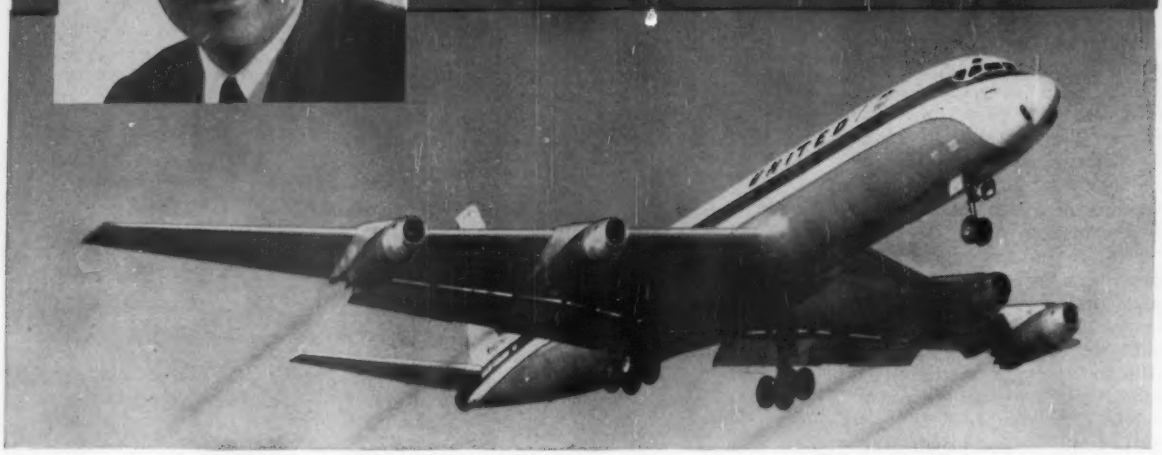


SIDE LOBE SUPPRESSION SYSTEMS FOR
AIR TRAFFIC CONTROL RADAR BEACON SYSTEM

PROPOSED side-lobe and reflection suppression techniques to date include Stewart-Warner, USAF's Rome-Setrin, and the ICAO standard two-pulse system. System proposed by FAA is a composite of the features of these other systems which is similar to the Cossor system advocated by the United Kingdom several years ago.

"We're Proud of Douglas' Record of Aircraft Dependability"

... Donald W. Douglas, Jr.
President of Douglas Aircraft Company



AEROQUIP PRODUCTS ARE SPECIFIED FOR ALL DC-8s

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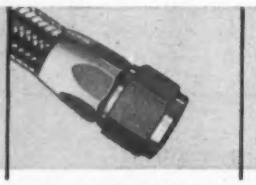
Aeroquip, too, is known for products of outstanding dependability. We, at Aeroquip, are proud of our long association with Douglas as a supplier of fluid line components. Aeroquip High Performance Hose Lines, Self-Sealing Couplings and Precision Tube Assemblies have been specified for every DC-8 aircraft now on order by 18 certified air lines throughout the world.

Aeroquip's extensive engineering experience and production capability help to simplify design and development of fluid systems for aircraft/missile manufacturers.

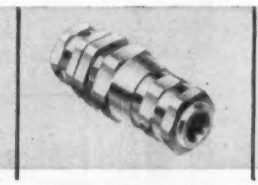
And the inherent time-saving and money-saving advantages of Aeroquip products make them ideal for commercial and corporate aircraft fluid system maintenance programs.

How can Aeroquip help you?

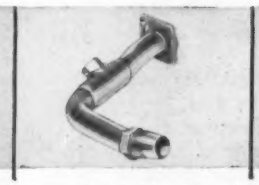
Aeroquip 666 Hose Lines of Teflon with patented* Reusable "super gem" Fittings serve special high-temperature applications.



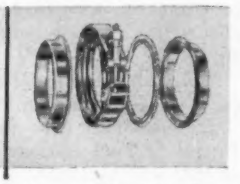
Aeroquip 601 High Performance Hose Lines and Reusable "little gem" Fittings are used on engine fuel and lube oil systems.



Aeroquip 5420 Self-Sealing Couplings are used on refrigerant lines of the DC-8's air conditioning system.



Aeroquip Precision Formed Tubing with integral hose fittings achieves exceptional weight savings and eliminates potential leak points.



Marman V-Band Couplings, Channel Band Couplings, Instrument Mount Clamps and Band Clamps are used on the Douglas DC-8.

Aeroquip
REG. TRADEMARK

GREAT BRITAIN

for Flexible Hose Lines, Industrial and Aircraft Applications
SUPER OIL SEALS & GASKETS, LTD., Birmingham Factory Centre, Kings Norton, Birmingham, England

for Self-Sealing Couplings, Marman Products and Load Control Equipment
KING AIRCRAFT CORPORATION, Fifth St., Montrose Ave., Hillington, Glasgow, S.W. 2, Scotland

FRANCE

TECALEMIT, Boite Postale No. 11, Paris 13e, France

GERMANY

AEROQUIP G.m.b.H., Baden-Baden, Germany

JAPAN

THE YOKOHAMA RUBBER CO., LTD., Otemachi Bldg., 4, 1-chome, Otemachi, Chiyoda-ku, Tokyo, Japan

CANADA

AEROQUIP (CANADA) LTD., Toronto 19, Ontario

U.S.A.

AEROQUIP CORPORATION, Jackson, Michigan; Western Division, Burbank, Cal., Marman Division, Los Angeles, Cal.

*"super gem" and "little gem" are Aeroquip Trademarks. *U.S. Patent Nos., 2,833,567 and 2,731,279*

fruiting) requires matched delay lines for storage. The complexity of this type of equipment could be reduced with a simple storage tube employing the tube phosphor to integrate two or more beacon responses for display.

There are at present three versions of the radar beacon system operating in the air traffic control environment. These are the Military Basic Mark 10 and Mark 10-SIF (Secure Identification Feature) IFF equipments, and the Civil Air Traffic Control Radar Beacon System. Mode 3—the mode is determined by the spacing of the interrogation pulses—of the military systems is the same as the civil Mode A. This common mode has been designated for use by both civil and military aircraft operating in the ATC Common System.

Ground Facilities

Ground facilities that are now operational, or will be by the end of the month, include La Guardia, Newark, Idlewild, Chicago-O'Hare, and Washington Towers, and the Idlewild, Chicago-Midway, Washington, and Norfolk Air Route Traffic Control Centers.

Beacon responses are displayed on indicators associated with the primary radars. For this reason, use of the beacon system is limited by the associated radar display to an operational radius of 50 mi. from control towers and 200 mi. from control centers.

In addition to its own commissioned facilities, the FAA has other operating facilities which employ Mark 10 IFF interrogators on loan from the military. The airlines agreed in 1956 to equip their aircraft as rapidly as the ground interrogation and display facilities were implemented. In 1958, the airlines also agreed to equip all aircraft operating above 24,000 ft. to permit positive and continuous identification and control of all aircraft operating above this altitude layer.

Under present plans, 64 codes are available in the joint civil-military mode. Sixty two of these codes are used for military purposes and by air traffic control. Two codes have been standardized for use on a nation-wide basis. Code 77 (in the octal-numerical system) is to indicate an aircraft emergency. Code 00 is for use in defense missions such as Air Defense Command fighter scrambles.

Sufficient equipment is now being procured, and scheduled for delivery by 1961, to equip 54 ground facilities. These will have dual channel interrogation, 10 channel decoders, and active readout. This means that, after installation and commissioning, these facilities will provide almost complete coverage of the United States. The holes in this coverage will be filled by equipment being procured this fiscal year and next.

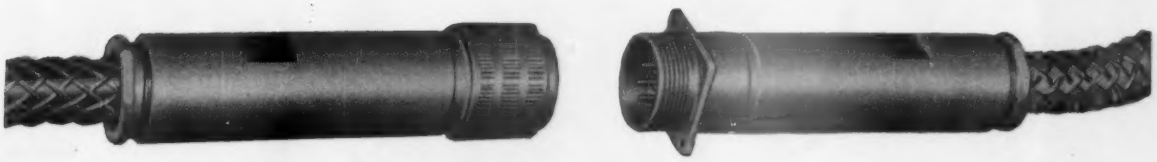
Because it would be of mutual benefit if all users of the airspace were beacon equipped, and would increase the traffic control service that could be supplied, the FAA is supporting the development of a lightweight, minimum cost transponder.

Types of Facilities

The airspace over the continental United States will be under the control jurisdiction of three basic types of air traffic control facilities: en route, transition-terminal, and airport traffic control tower facilities.

En route facilities normally will exercise control of the airspace above 24,000 ft. The lateral boundaries will encompass a much larger area than the en route control areas of today. Equipment at these facilities will permit the transfer of control data automatically from one center to another. Under these present concepts, there will be positive separation of all aircraft operating within the en route areas. They will function by correlation of flight plan data with aircraft position data. Additionally, positive separation will be provided below the en route area where traffic densities necessitate this service.

Transition-terminal facilities will pro-



Why it pays you to specify

Bendix QWL Electrical Connectors for use with Multi-conductor Cable

For use with multi-conductor cable on missile launching, ground radar, and other equipment, the Bendix* QWL Electrical Connector meets the highest standards of design and performance.

A heavy-duty waterproof power and control connector, the QWL Series provides outstanding features: • The strength of machined bar stock aluminum with shock resistance and pressurization of resilient inserts. • The fast mating and disconnecting of a modified double stub thread. • The resistance to loosening under vibration provided by special tapered cross-section thread design. (Easily hand cleaned when contaminated with mud or sand.) • The outstanding resistance to corrosion and abrasion of an aluminum surface with the case hardening effect of Alumilite 225 anodic finish. • The firm anchoring of cable and effective waterproofing provided by the cable-compressing gland used within the cable accessory. • The watertight connector assembly assured by neoprene sealing gaskets. • The additional cable locking produced by a cable accessory designed to accommodate a Kellems stainless steel wire strain relief grip. • Prevention of inadvertent loosening insured by a left-hand accessory thread. • The high current capacity and low voltage drop of high-grade copper alloy contacts. Contact sizes 16 and 12 are closed entry design.

These are a few of the reasons it will pay you to specify the Bendix QWL electrical connector for the job that requires exceptional performance over long periods of time. *TRADEMARK

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Ill.; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

Scintilla Division
Sidney, New York

Bendix
AVIATION CORPORATION

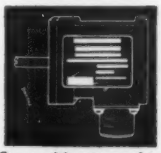
another subsystem from ***Giannini...***

Stall Warning System for Douglas Cargomaster

A reliable, accurate system to provide advanced crew warning of approaching stall conditions was required for the Douglas C-133 Cargomaster.

Giannini met this requirement by designing a *Stick Shaker* Stall Warning System which produces a vibration on the control columns... warning the pilot of impending stall conditions in time to permit corrective action. Giannini components making up the system include an angle of attack transmitter, flap positioning transmitters, amplifier and control column shaker circuitry. For additional data on the Stall Warning System, send for Giannini Case Study No. 104.

angle of attack transmitter



flap position transmitter

GCC 9-14

Giannini Controls Corporation *918 E. Green Street, Pasadena, California*

Engineering opportunities now exist at Giannini for work on similar avionic systems. Introduce yourself by writing to the Director of Technical Personnel.

vide air traffic control for operations below 24,000 ft. Boundaries of these areas also will include areas not covered by radar surveillance. The FAA visualizes the continuation of tower en route control functions for short-haul operations.

These facilities will be equipped to operate compatibly within the national system.

Control towers will be responsible for traffic control and aircraft surface movements. The tower also will be responsible for the area within the immediate vicinity of the airport under the visual surveillance of the controller. Other responsibilities may be delegated to the tower by a transition-terminal or en route facility.

Side Lobe Suppression

One of the future developments anticipated by the FAA is international agreement on one common technique for side-lobe and reflection suppression. There now exists an International Civil Aviation Organization standard two-pulse side-lobe suppression system for one of the modes not likely to be used within the United States in the immediate future. At the time this standard was set up, no agreement could be reached between this country and the United Kingdom on a suppression technique for the common civil-military mode to be used here.

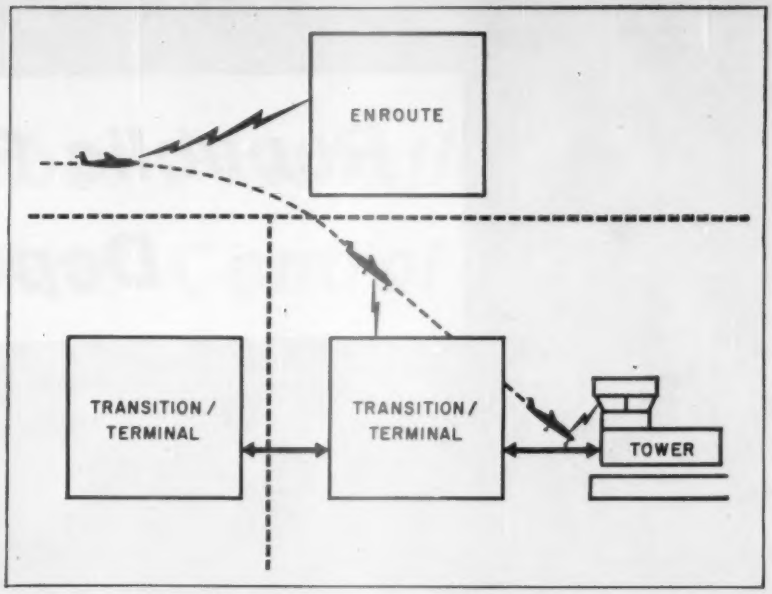
This summer the FAA sent a delegation to the United Kingdom to discuss the characteristics of the FAA-proposed three-pulse suppression technique.

This proposal was based on extensive field operation tests in the high density New York area, plus data gathered from simulation by means of a mathematical model.

The proposed FAA system is a composite of the better features of several previously proposed and tested systems, including the Stewart-Warner, Rome-Setrin, and the ICAO standard two-pulse systems. This composite system is similar to the Cossor system advocated by the U.K. at the time the ICAO standard was adopted. Agreement now awaits study by the British of the FAA test results in the New York area plus tests of their own. The comments of transponder manufacturers, airline operators, and the military services concerning the FAA approach have been solicited.

When national and international agreement is reached, the FAA will adopt the resulting system characteristic and direct its use by both civil and military users of the common ATC system.

The third development in progress is the storage-tube type defruiter. By retaining the coded response pattern of an airborne transponder received during one interrogation cycle and comparing it with the response pattern received during a second interrogation cycle, it is possible to display only the replies that are synchronous and reject, or filter out, the non-synchronous returns and noice commonly referred to as fruit.



AIRSPACE over U. S. will be under the control jurisdiction of three basic air traffic control facilities: en route, transition-terminal, and airport traffic control tower.

Existing Equipment

Existing defruiting equipment uses matched delay lines as the method of storage. These defruiters are capable of comparing two interrogation cycles (single defruiting), or comparing three interrogation cycles (double defruiting). Tests in the high density New York environment indicate that single defruiting is adequate, and that double defruiting at times prevents the display of valid responses.

The delay-line type of defruiter now in use requires carefully balanced delay lines, matched accurately to the pulse repetition frequency and other parameters of the primary radar.

The storage tube defruiter offers the advantage of being universally adaptable to parameters of any radar, provided that the resolution of the storage tube is sufficiently high. The FAA is investigating a storage tube being developed in France which may have better resolution capabilities than those produced here.

According to the position of the FAA, the primary function of the beacon system is to reinforce the radar target in providing positional information. This position information includes altitude. Both this country and the U. K. are investigating the addition of an automatic altitude reporting function to the beacon system. This is possible by properly coding interrogations to the airborne transponder which would then transmit back altitude information from the aircraft's altimeter in the form of pulse code.

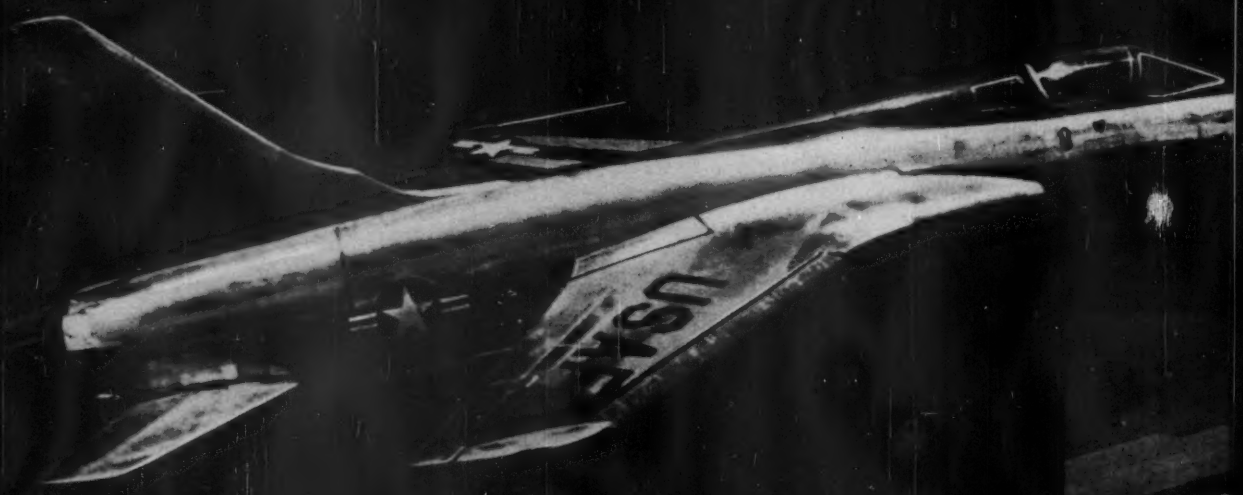
The question that is raised immediately by including an altitude reporting function is that the beacon transponder is then being converted into a data link. According to Shoemaker, this represents one of the possibilities being considered. He said that, in the same manner, heading, air speed, or other aircraft data desired on the ground could be relayed in this fashion. The question as to whether such information will be supplied by the beacon system or by another system such as AGACS (Automatic Air-Ground-Air Communications System) is largely an operational decision.

Additional Improvements

Other planned improvements contemplated for the beacon system are:

- **Increasing the number** of possible reply codes from 64 to in excess of 4,000. This possibility is being considered and can be made available if justified by operational needs. Twenty experimental transponders are being developed now with this capability included.
- **Performance monitors** for the ground interrogation facilities, and improved beacon antennas are planned. Beacon attachments for the PAR (Precision Approach Radar) and ASDR (Airport Surface Detection Radar) systems will be provided if needed.
- **Multiple channel decoder,** capable of decoding altitude data as well as identi-

Republic F-105—One Depends Upon



New Wings for the Eagle!

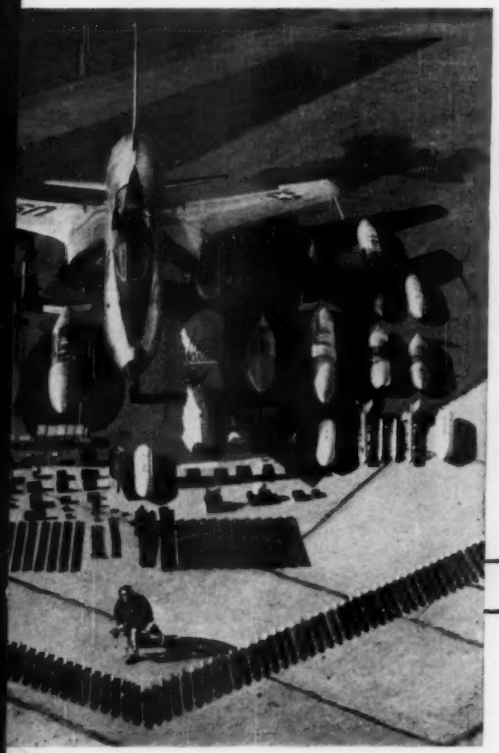
World War II's famed Eagle Squadron, now the 335th Squadron of TAC's Fourth Fighter Wing will soon be flying the F-105 fighter-bomber.

Plane "Bomber Formation" Holley for Fuel Control

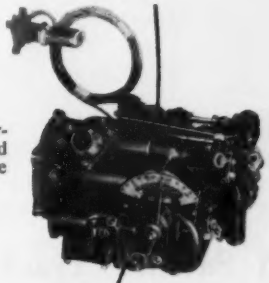
World's most powerful one man airplane, is reported to carry "as much destructive power as an entire big bomber formation of World War II." Capable of carrying an atomic bomb, the exciting Republic "Thunderchief" gets more than 25,000 pounds of thrust from its Pratt & Whitney Aircraft J75 jet engine with afterburner.

Holley designed, engineered and manufactures the main fuel control, bleed governor and actuator for the J75 engine which has both military and commercial applications. The Holley R-95 control combines "small package" design with light weight and exceptional performance reliability. It's another important reason why more and more engine and air frame manufacturers are turning to Holley for engine components.

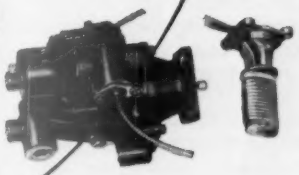
This impressive array of fire power shows why the Republic F-105 supersonic jet is often billed as the "one man airforce."

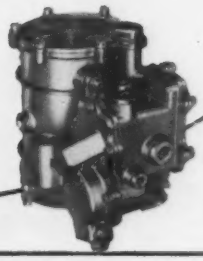


The R-95 is the military version of Holley designed and engineered fuel controls made for the J75 jet engine.



Both the Holley R-98 compressor bleed governor and its companion, the bleed valve actuator (below), are designed and manufactured for the J75 engines.

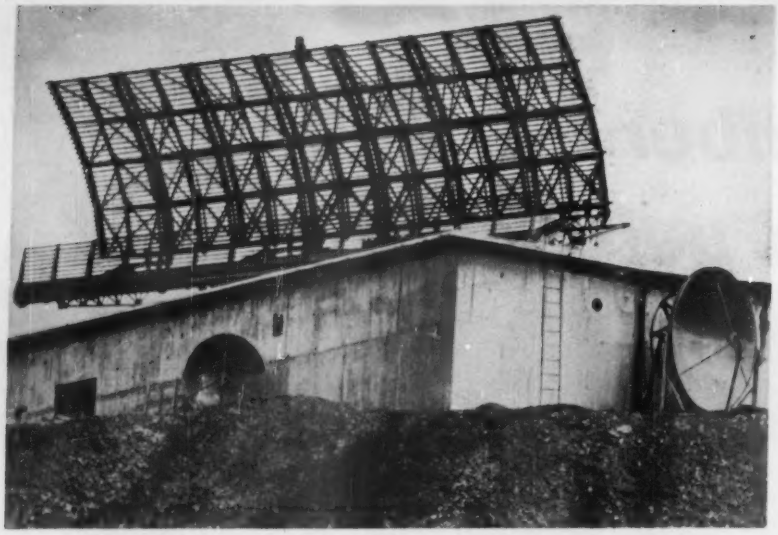




HOLLEY Carburetor Co.

A-29 11955 E. NINE MILE ROAD
WARREN, MICHIGAN

Leader in the Design, Development and Manufacture of Aviation Fuel Metering Devices



Marconi Radar Installed in New Zealand

Wellington, N. Z., airport has recently installed Marconi Wireless Telegraph Co.'s Type S264A 500 kw. 50 cm. radar. Dual transmitter-receiver installation is at a site located on a ridge 1,300 ft. high, and is remotely controlled from the Airways Control Center via a four-mile, two-way microwave link. Radar target data also is transmitted to the airport tower over a second microwave circuit. Radar and microwave antennas are shown above.

fication, is scheduled for development soon. This decoder will be incorporated into the automatic processing and ground display equipment being provided in the future.

Some of these changes may necessitate modification of equipment now in use both on the ground and in the air. Shoemaker stressed, however, that these modifications would be made only if they provide a sufficient improvement in the ATC service to justify them.

IGY Satellite Tracked By Chance Vought

Dallas, Tex.—Tracking and monitoring of satellites passing the Hawaiian Islands area is being provided by Chance Vought Aircraft, Inc.'s Range Systems Division. Under an expanded Navy contract, the division is tracking and recording telemetered data from National Aeronautics and Space Administration's heavy IGY composite radiation satellite.

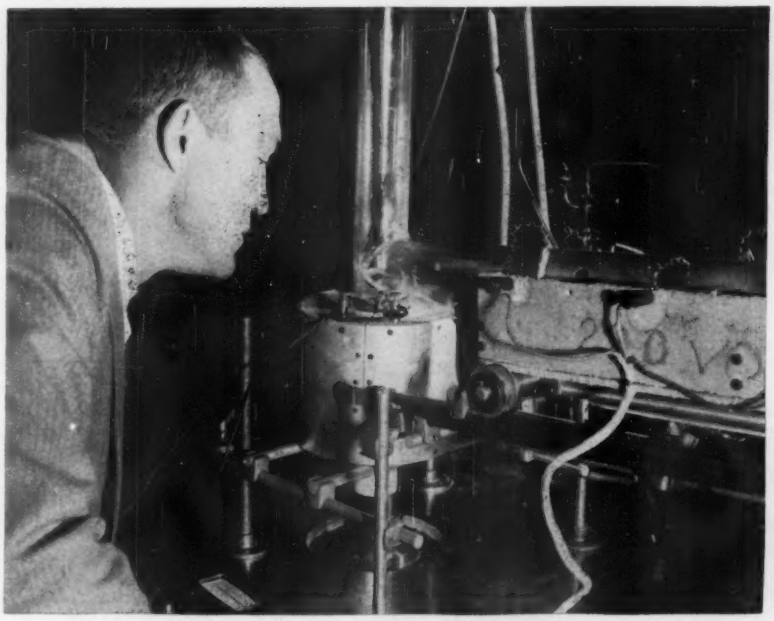
Space vehicle monitoring may be expanded to include other satellites in the future. The NASA satellite is collecting data on radiation, charged particles and micrometeorites. For the past six months, the company has been operating the Pacific Missile Range's fleet training facility, tracking and collecting accuracy data for fleet submarines and cruisers launching Regulus I missiles. The radar also tracks aircraft flying simulated Regulus attack patterns. Missions also include Regulus land launches.

FILTER CENTER

▶ **Antenna Height vs. Gain**—Data which describes how strength of a signal received beyond the radio horizon in a tropospheric scatter communication system varies with receiver and transmitter antenna height, measured by National Bureau of Standards physicists, now is available in an 86-page report entitled "An Analysis of Propagation Measurements Made at 418 mc. Well Beyond The Radio Horizon." NBS made continuous, simultaneous recordings of signal level with receiving antenna heights ranging from 30 to 665 ft. Copy of the report, identified as PB 151365, may be obtained for $2.25 from Office of Technical Services, Department of Commerce, Washington 25, D. C.

▶ **Bids for Satellite Radar**—More than 30 avionics companies have submitted bids to NASA for a lightweight weather radar to be used in a meteorological satellite (AW Aug. 17, p. 61). Selection of winner is expected to take at least a month.

▶ **Promising New Thin Film Materials**—Materials research at Battelle Memorial Institute under Air Force sponsorship has disclosed several new compounds with promising characteristics for deposited microcircuitry. For example, chromium-titanium-nitride can be deposited with resistances of 60 to 800 ohms per square, depending upon film thickness and the nitriding temperature, according to Battelle's Edwin H. Layer. Chromium-silicon films show greater stability than nitrides, with no appreciable resistance change even when ex-



Battelle Produces High-Purity Compound

Indium antimonide specimen suspended in the glass column, to be used in low-temperature transistors and infrared detectors, represents the purest crystal ever made of any compound (99.999999 plus), according to Battelle Memorial Institute, which produced it under a contract with USAF's Office of Scientific Research.

AN ACHIEVEMENT IN DEFENSE ELECTRONICS

NEW AMPLIFIER PACKS 90 DB IN HALF CUBIC INCH VOLUME

New 455 kc three-stage amplifiers developed by the U.S. Army Signal Corps utilizing the facilities and competence of General Electric produce up to 90 db gain with 5 kc bandwidth in one-half cubic inch volume. This degree of miniaturization evolved from sustained research and development in solid state filters, delay lines and transformers at the Electronics Laboratory, Electronics Park.

The unique bar-shaped transformers developed for these amplifiers, combined with improvements in existing ferro-electric ceramics, permits the most compact packaging with extreme gain. This achievement in research and development is indicative of General Electric's technical competence in defense electronics.

227-2B

Progress Is Our Most Important Product

GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION
HEAVY MILITARY ELECTRONICS DEPARTMENT
SYRACUSE, NEW YORK

Reliability Emphasized in AN/ARC-58

AN/ARC-58 high frequency single sideband airborne transceiver has compiled a record of 160 hr. mean time between failure, according to Collins Radio Co., which developed the equipment for the Air Force. Factory reliability run shown above takes all production units through a minimum of 40 hr. of operational cycling to simulate actual use. Collins attributes over 580 design improvements early in the program to its reliability program.

posed to the air at temperatures of 500F for thousands of hours. Films deposited with 24% chromium and 76% silicon can provide resistances of 100 to 10,000 ohms per square, depending upon film thickness and temperature of substrate. Indium oxide film has a resistivity of 0.01 to 0.001 ohm-centimeter, permitting its use as transparent electrodes.

▶ **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Federal Division, International Telephone & Telegraph Corp.,** Clifton, N. J., $3.4 million award from the Martin Co. for production of guidance units for Lacrosse missile.

• **Wilcox Electric Co.,** Kansas City, $8 million contract from Army for AN/APX-44 radar transponders.

• **Collins Radio Co.,** Cedar Rapids, $231,000 contract for FM-CW doppler radar systems from Trans-Canada Air Lines for installation on its Douglas DC-8 jetliners.

• **Avnet Electronics Corp.** reports net sales for the first quarter ended Sept. 30 totaled $2,132,091, compared with $1,345,246 for the same 1958 period. Net profits after taxes for this year's first quarter were $255,713, compared with $161,002 for the quarter ended Sept. 30, 1958. Avnet Electronics produces and assembles connectors and other items.

• **Packard Bell Electronics,** Los Angeles, $250,000 for airborne interrogators for use in rescue and refueling missions, from Air Materiel Command. Device interrogates radar transponder in another aircraft and displays visually the location of the other aircraft from its response.

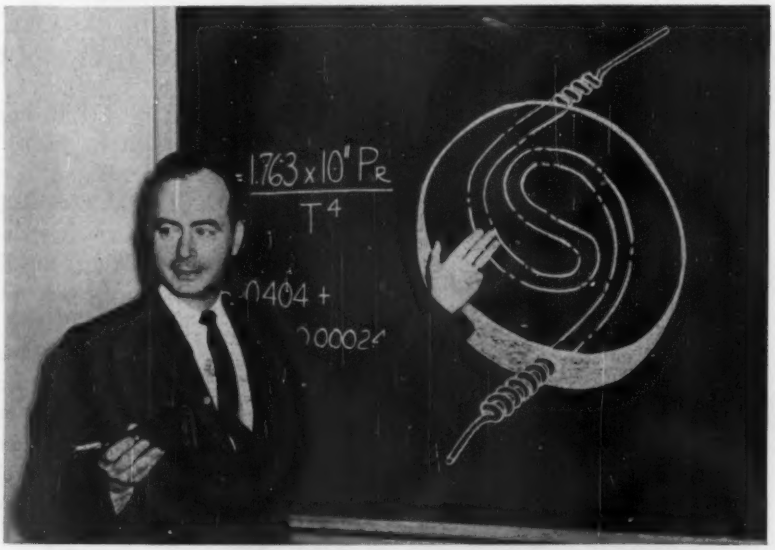
• **Consolidated Avionics Corp.,** Westbury, N. Y., $400,000 award from Rome Air Materiel Area for data processing.

• **Kearfott Co.,** Little Falls, N. Y., two letter contracts totaling $1.2 million from Air Materiel Command as initial funding for product improvement program on its AJA-1 true heading computer and N1 directional gyro compass system, jointly designated the AN/AJN-8, used on Boeing B-52 and KC-135 aircraft.

• **Radiation, Inc.,** Melbourne, Fla., $476,000 award to develop a tape format converter for converting airborne telemetry data from Minuteman intercontinental ballistic missiles into a form suitable for direct entry into ground-based computers. Contract is the third awarded to the company for the Minuteman program.

• **Consolidated Electrodynamics Corp.,** Pasadena, Calif., $352,800 award from Federal Aviation Agency for recording oscillographs to be used for flight inspection of air navigation aids.

• **Radar data handling equipment** for National Aeronautics and Space Administration's rocket test station at Wallops Island, Va., will be built by Electronic Engineering Co. of Calif., under a $207,000 contract for three systems to convert data from missile tracking radars for computer input.



Miniaturized Cathode Ray Tube Developed

Miniaturized cathode ray tube assembly, resulting from a combination of powder metallurgy and modern vacuum tube technology, has been developed by Sylvania Electric Products, Inc. External radiating surfaces of the heater-cathode assembly is more than 25 times smaller than conventional structures. Assembly is sketched by H. E. Smithgall of Sylvania.

Airborne Digital Timer Highly Accurate

By Erwin J. Bulban

Dallas, Tex.—Precision lightweight airborne digital timing system developed by Temco Aircraft Corp. for USAF is rated as having an accuracy of one part in 10^9, with starting accuracy within two milliseconds of setting. System provides visual indications in the form of six-digit numerical clocks as well as video signals for audio and/or graphic recording. This signal is in the form of a binary decimal code furnishing real time reference.

Developed by the Temco Overhaul and Aerosystems, Greenville, Tex., the system can be started manually by inserting any chosen time or automatically synchronizing the time generating process with transmitted signals. It automatically corrects for propagation delay time.

Further development includes a weight reduction program (system now weighs 78 lb. with one remote clock and one reader control), size reduction program and extension of synchronization to include all known standard time signals throughout the world.

It now operates on U. S. time signal WWV.

System works as its own decoder and readout device for previously recorded binary coded video signals, providing real time display in decimal form to the nearest second using the remote reader control.

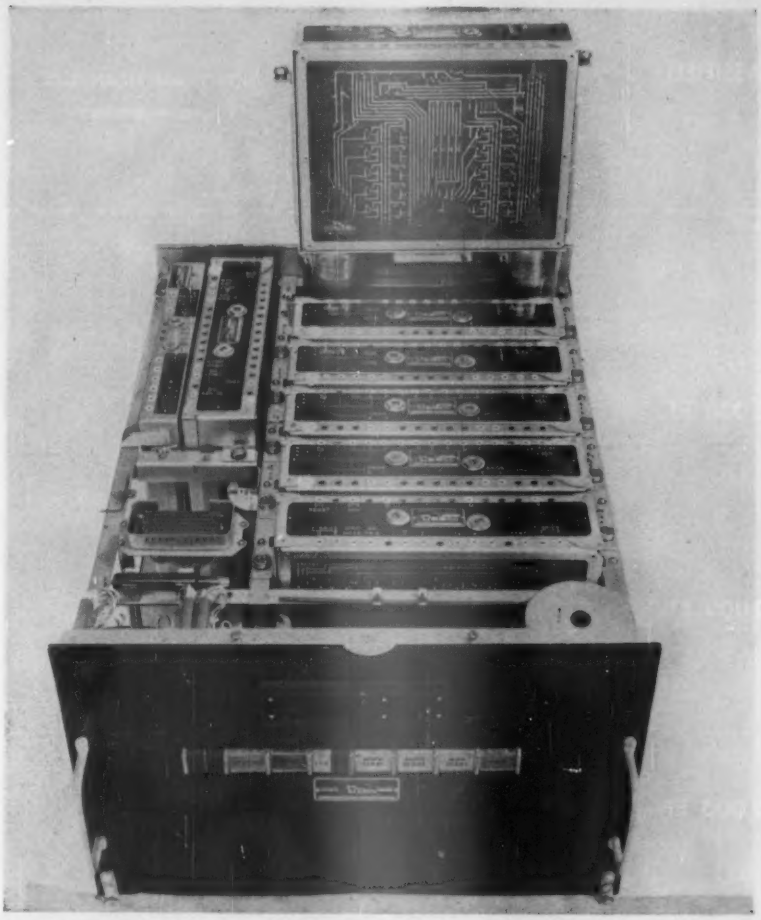
Time referencing can be reduced below the one-second level with 0.1, 1, 10 and 100 millisecond markers.

Basic Components

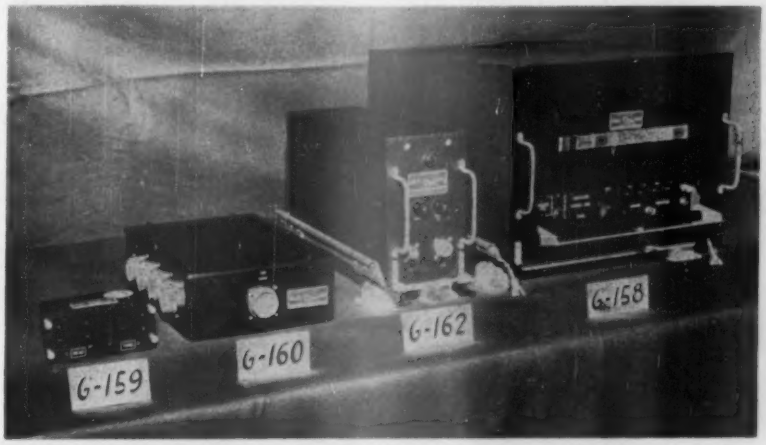
Basic components making up the system include: time encoder reader, remote clocks, junction box, remote reader control and power supply. The time encoder reader is of modular construction utilizing beam switching tubes and transistorized printed circuits. Miniaturized remote clocks use six numerical indicator tubes for presentation of real time.

Transistorized power supply uses both magnetic and transistor regulators. Silicon semiconductor devices and tantalum electrolytic capacitors allow operation in ambients of −55C to 71C without forced air cooling.

System is designed for operational simplicity and minimum of operator skill. Dial controls are used to put in nautical miles from operator's station to an automatic WWV transmission; the system converts distance to propagation delay time so that the signal is set to generate real time as soon as it receives the transmitted signal.

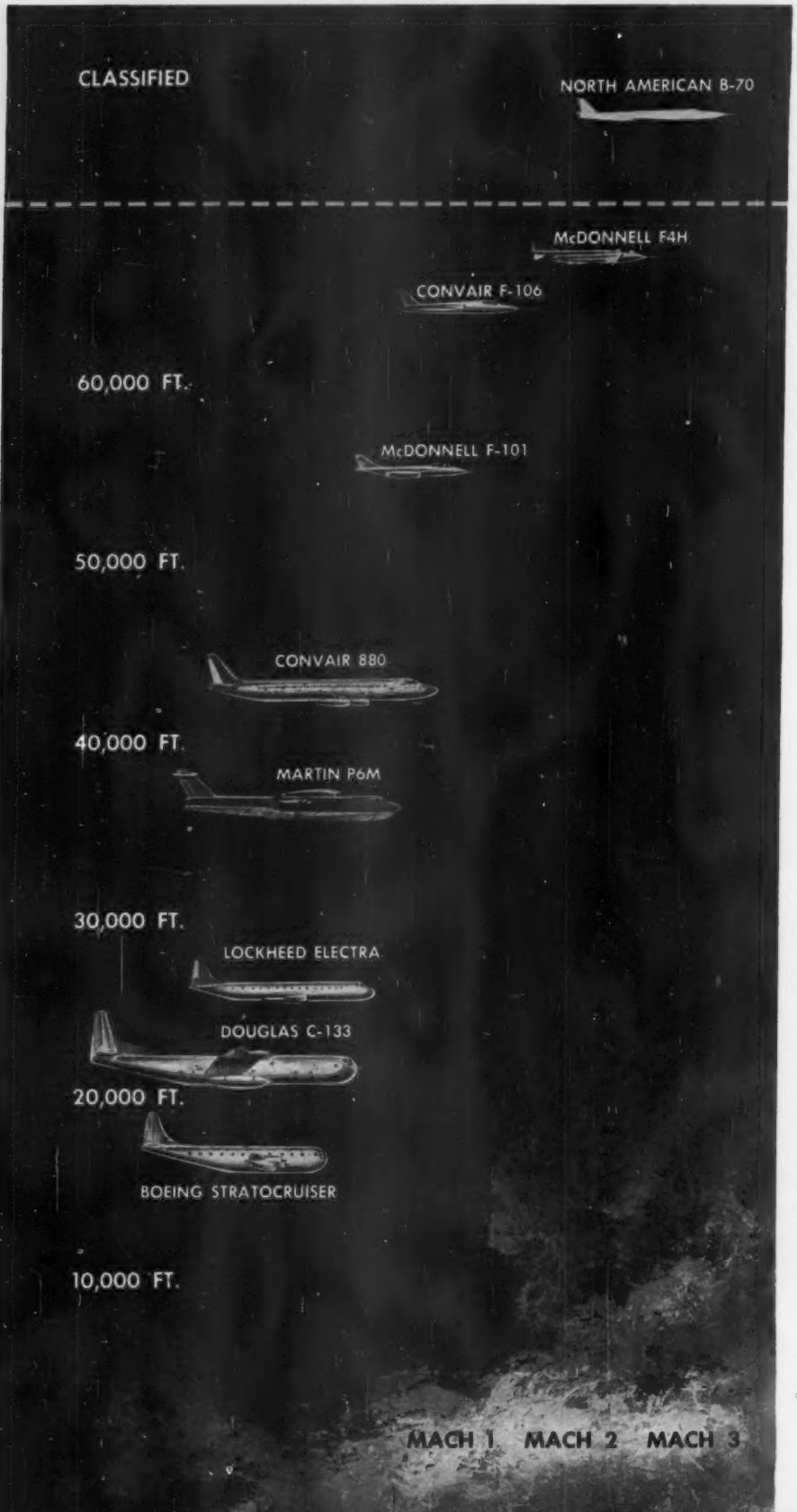


MODULAR DESIGN in Temco Aircraft Corp.'s time encoder reader provides fully transistorized printed circuitry, with units easily pulled out for inspection and servicing. USAF application to provide real time for data correlation is secret and may remain so for years.



AIRBORNE digital timing system developed by Temco Aircraft Corp. comprises, left to right, remote clock, junction box, power supply, and time encoder reader. Entire system weighs approximately 78 lb.; further development includes a weight reduction program.

'CONTINUED LEADERSHIP IN SECONDARY POWER EQUIPMENT



General generating

General Electric has been selected to supply the advanced-design secondary electrical power generating system for the North American B-70 Valkyrie, the Air Force's new MACH 3 multi-purpose bomber.* Designed for supersonic high-altitude operation with inherent long-range flight endurance and large load-carrying capability, the B-70 can be adapted to offense, defense, reconnaissance, or special airlift missions.

The new, specially designed G-E system consists of an Inductor-Lundell generator, controlled-rectifier regulator, and protective panel. The revolutionary generator, newly applied to aircraft systems, will provide extreme system reliability by eliminating normally required brushes, slip rings, commutators, rotating windings, and rotating rectifiers.

Development of this system for MACH 3 aircraft offers a challenge never before encountered in manned aircraft. New lubricating and insulating methods and new sturdy, compact construction are needed to stand flight stresses three times the speed of sound at altitudes previously unreached by operational aircraft.

Some equipment will be required to withstand temperatures of 600 F, vibration input of 15 g's (as much as 60 g's locally), and shock of 20 g's. Extreme reliability is, of course, a must.

In developing this equipment, General Electric is using experience and knowledge derived from the material and component development phase of a separate Air Force High-temperature (HOTELEC) Program under subcontract from North American Aviation. G.E.'s completely equipped research and manufacturing facilities are ideally suited to develop and produce advanced systems like HOTELEC and the B-70. And, G-E leadership in secondary power equipment extends through 40 years and more than 50 different aircraft.

*Sundstrand Aviation is manager of the B-70 secondary power system for North American Aviation, Inc.

Aircraft pictured represent only a few of those for which G.E. has developed secondary power-generating systems.

Electric's new concept in aircraft systems is awarded B-70 contract

Design Concept

Design innovations in the new G-E generating systems will provide outstanding results in these areas:

• **Reliability**—Key to the increased reliability of the G-E system, is the revolutionary Inductor-Lundell generator. Field windings and rectifiers will be located in the stator instead of the rotor as in conventional machines. Lower component temperatures result from shortening heat-transfer paths between windings and coolant.

In addition, all available control components—relays, transistors, magnetic amplifiers, controlled rectifiers, capacitors, and resistors—were fully evaluated as to performance and reliability. Then exhaustive research—speeded by computers—was conducted on individual circuits of each system to determine the combination of components which would provide maximum reliability and minimum weight for each particular application.

• **Electrical configuration**—It is planned that the B-70 system will consist of four 60-kva generators in parallel for main and emergency power. Through careful system designing, there will be a precise integration of generators with necessary control, regulating, and protective components.

• **Light weight**—Unnecessary weight will be eliminated by (1) combining Inductor and Lundell generator principles, (2) utilizing the generator frame as flux path, (3) use of more efficient magnetic material in the frame, and (4) integrating bearing and cooling and lubricating systems with the Air Vehicle Sundstrand Drive.

Weight also will be saved in another way. In analyzing the complete B-70 system, North American electrical engineers felt that the long feeder runs from generator to load offered an excellent opportunity to evaluate a variety of generator voltages, feeder sizes, and transformer designs to determine the optimum combination. Coordination with General Electric indicated the practicability of such a design breakthrough. As a result, it was decided that power will be generated and transmitted at 240/416 volts and stepped down to 115/200 volts at the load by novel transformers designed specifically for this application. A net weight saving to the aircraft of hundreds of pounds was thus accomplished together with improvement in electrical transmission and cooling efficiencies.

Future Application

General Electric research on this system holds bright promise for future applications. Further development will make similar systems available in many future ratings and sizes for other types of aircraft. For more details, contact your General Electric Aviation and Defense Equipment Sales Office or write Section 796-1, General Electric Company, Schenectady 5, N. Y.

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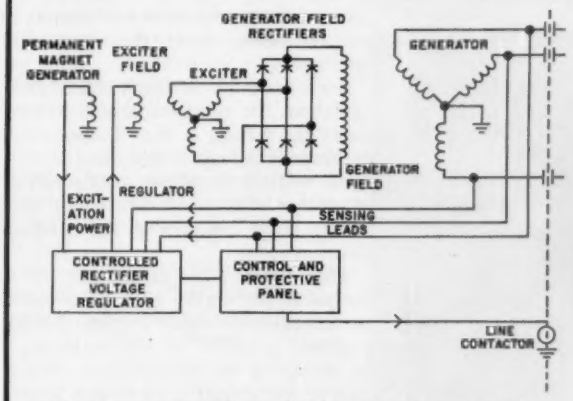
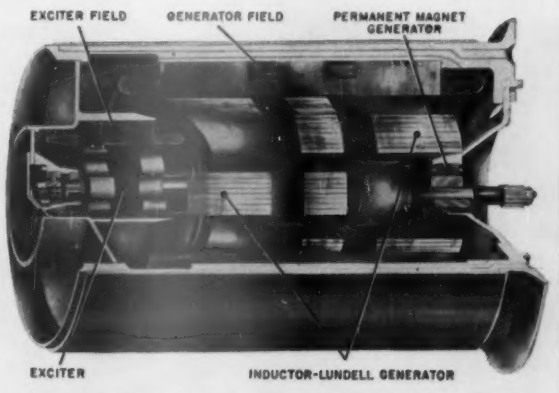
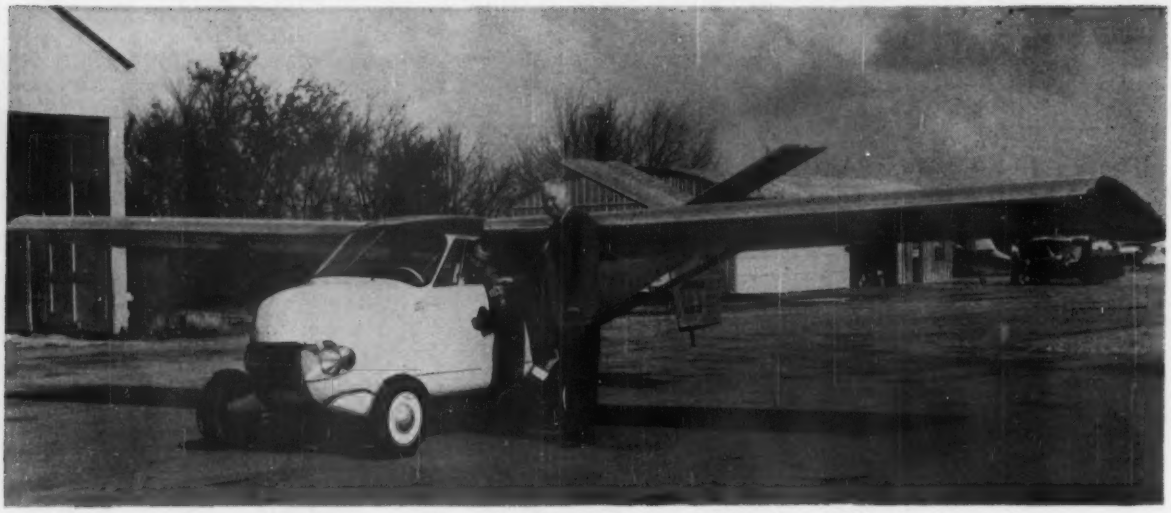


This elementary schematic diagram shows the arrangement of generator and control components.



Cross-sectional view of the Inductor-Lundell configuration of the secondary power system generator.



FIRST delivery of an Aerocar pre-production model is made to Marshfield Airways, Massachusetts dealer for the vehicle.

Aviation Week Pilot Report:

Aerocar Makes Quick Airplane Transition

By Barry Tully

Teterboro, N. J.—Aerocar, the flying automobile, is ready to take to the air (and/or the road) after an 11-year gestation period.

The two-place vehicle, designed for the man who wants to drive to the airport, fly to another and drive to his ultimate destination all in the same conveyance, will be produced in 1960 if present licensing negotiations are successful. Aerocar, Inc., Longview, Wash., developer of the vehicle, is negotiating with United States and European manufacturing companies for the production of the Aerocar. At present, it appears likely that the Aerocar will be produced in West Germany.

One pre-production unit has been sold to Marshfield Airways, a Massachusetts dealer for the vehicle. Aerocar, Inc., says it now has 22 firm orders ($1,000 deposits) for the Aerocar at a unit price of $9,500. The desired sales goal is 100 orders prior to production.

Aerocar N103D was demonstrated to AVIATION WEEK, in all its modes of utility, at Teterboro Airport by Moulton Taylor, the vehicle's designer.

Unusual Characteristics

In its flight configuration, the Aerocar presents four unusual characteristics to the observer:

• **Four-wheel landing** gear provides roadability when the vehicle is in use as an automobile.

• **Internally-mounted engine,** a four cylinder Lycoming 0-320 developing 143 hp., is located behind the cabin seat. A fan cools the air-cooled engine.

• **"Y tail" configuration** has horizontal stabilizers with 25 deg. positive dihedral and the vertical fin and rudder projecting downward from the fuselage.

• **Pusher propeller,** a ground-adjustable Hartzell, is mounted on the empennage aft of the control surfaces. This propeller location, although not originating with the Aerocar, undoubtedly turns the most heads among airport onlookers. In flight, however, the aft mounted prop appears to produce no adverse effects and obviously permits a smooth airflow about the wings and fuselage.

Aside from the Aerocar's radical configuration, the most impressive feature about the vehicle is that it does what its proponents say it will do (i.e. fly, drive, convert from one configuration to another in approximately 5 min. and tow its flight components on self-contained wheels).

The Aerocar, as an aircraft, is a two-place, high wing monoplane with an internally-mounted engine driving a pusher propeller on the empennage by means of an 11 ft. shaft. Wing span of the aircraft is 34 ft. and length is 21 ft. 6 in. Empty weight is 1,500 lb., and useful load is 600 lb.; allowable baggage weight is 100 lb.

Dual aircraft controls are provided in

AEROPLANE, non-roadable, four-place Aerocar version, will utilize Aerocar wing and tail and will fold its wing (for storage). The nose is lengthened and the automotive components eliminated to provide for two additional passengers.

the Aerocar. Aileron and elevator movement is controlled by means of the large automotive steering wheel on the left and with a small control stick for the right seat occupant. The steering wheel, which moves forward and aft to provide pitch control, is locked for automotive use and unlocked by touching the rudder pedals. Two sets of rudder pedals are provided and the hand throttle is located in the center of the instrument panel.

The automobile clutch, brake and accelerator are located between the rudder pedals on the left side. This requires a certain amount of orientation, particularly for the pilot who must remember to use the automobile brake when taxiing. The pilot also has the option of using the foot throttle when taxiing.

Aircraft instruments in N103D are limited to a tachometer, altimeter, airspeed indicator and cylinder head temperature gage arranged across the panel.

A ball indicator on the left provides a balanced flight check, and a magnetic compass is located above the windshield. The fuel quantity gage and the oil pressure gage are arranged with the automobile speedometer.

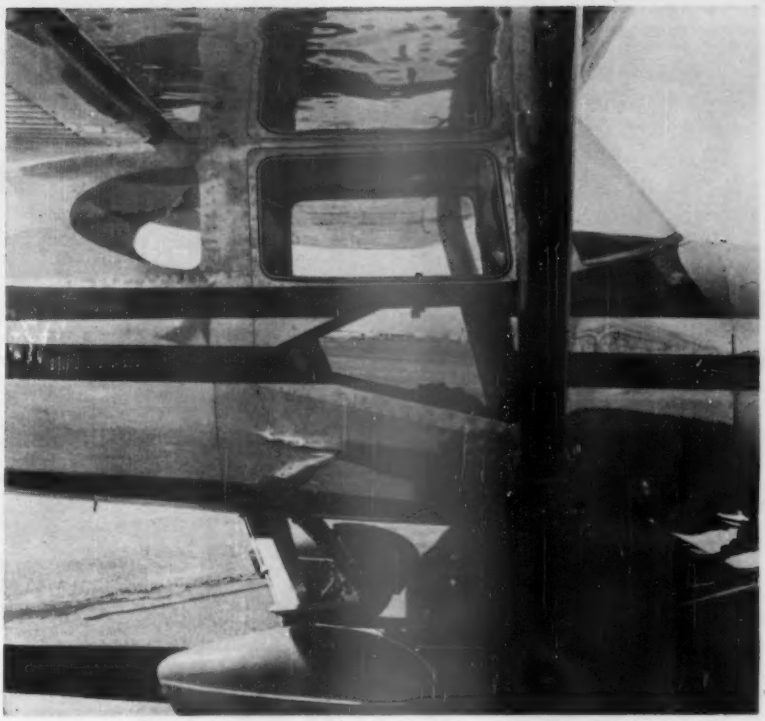
After starting the engine, the automotive gearbox may be engaged in reverse gear and the aircraft will move backward with the propeller turning. In taxiing forward, the gear lever is placed in neutral.

Easy to Taxi

Taxiing the Aerocar is quite easy. Directional control is maintained with the steering wheel, power is applied with either the automobile accelerator or the hand throttle and the foot brake slows or stops the aircraft. Most people use the foot throttle to taxi, as the engine returns to idle upon the release of pressure.

Taylor says the Aerocar will become airborne in 650 ft. My takeoff roll, however, took considerably more than that distance. After taxiing out for a rolling takeoff, I continued to accelerate the vehicle using the foot throttle. Taylor remarked that this technique would produce only 1,500 rpm. (40 hp.), hardly enough for takeoff. An abashed push on the hand throttle brought the desired 2,550 rpm. (27 in. of hg. and 135 hp.) and the takeoff was continued.

Directional control throughout the takeoff roll was excellent. The Aerocar is steered by means of the steering wheel until rudder response is felt in the pedals. A slight rotation will bring the front wheels off the runway; increased rotation at about 55 mph. will lift the aircraft off the runway nicely. However, conservatism and a long runway led to keeping the plane on the



Cessna 150 Fitted with 'Patroller' Door

Two-place Cessna 150 utility lightplane now is available with "patroller" doors fitted with a Plexiglas panel in the lower half to provide increased visibility during pipeline patrol and similar operations. These doors can be purchased separately and fitted to any of three versions of the Model 150 at a cost of $145, on an exchange basis. Patroller wings, with a usable fuel capacity of 35 gal., compared with the normal usable 22.5 gal. fuel capacity, increase the normal range from 630 mi. to 980 mi. and are available from the factory, again on an exchange basis for a cost of $157.50. A message chute, costing $19.50, can also be added on the left side of the Model 150 cabin, just in front of the pilot's seat. Photo at top shows the "patroller" door installation on the copilot's side. Below, increased downward visibility from the pilot's side is evident in the photograph taken in flight.

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AVIANCA (Aerovias Nacionales de Colombia, S.A.)
BEA (British European Airways Corporation)
Braniff International Airways
Capital Airlines
Capitol Airways
CPAL (Canadian Pacific Air Lines)
Cruzeiro (Servicos Aereos do Sul, Ltda.)
Cubana Airlines
Delta Air Lines
Eagle Airways (Bermuda) Ltd.
Eastern Air Lines
Iberia Air Lines
Japan Air Lines
KLM (Royal Dutch Airlines)
LAN (Linea Aerea Nacional)
LAV (Linea Aeropostal Venezolana)
Lufthansa German Airlines
Mohawk Airlines
National Airlines
Northwest Orient Airlines
PAA (Pan American World Airways) Panagra
Panair do Brasil, S.A.
Piedmont Airlines
Real Aerovias Nacional
Riddle Airlines
SABENA Belgian Airlines
SAS (Scandinavian Airlines System)
Seaboard & Western Airlines
Southeast Airlines
Southern Airways
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deck until reaching 70 mph. on the first takeoff.

The aircraft climbed out at full power indicating 60 mph. Rate of climb was estimated to be about 500 fpm. The Aerocar was quite stable on climb-out and torque effect was negligible.

The general in-flight handling characteristics of the Aerocar are quite good. The aircraft is remarkably stable in climbs, glides, turns and in level flight. The light turbulence at low altitude near Teterboro did not affect the small aircraft adversely. Flying with the large automobile-type steering wheel, however, does require a period of adjustment. Additionally, the small nose of the aircraft and the lack of gyro horizon or turn-and-bank indicator make it difficult to determine a wings-level attitude. This, no doubt, comes to the pilot with experience.

One unusual flight characteristic of the Aerocar is the large control movement necessary to bank the aircraft. This is caused by the necessity to combine the steering geometry of the front wheels with that of aileron displacement. The compromise affords rather "tight" automotive steering and extremely loose aileron feel.

Rudder Response

Rudder response of the Aerocar is excellent, particularly at low airspeeds with the aircraft in a nose-high attitude. When trimmed for hands-off level flight, the aircraft will make a good banked turn after the initial yaw into a kicked rudder.

Stalls, both power-on and power-off, were conducted with the aircraft. In both cases the aircraft stalled at approximately 45 mph. indicated on a flickering airspeed indicator. The stalls, in both cases, were completely docile with no violent pitch down or tendency to drop a wing. Control response was good right down to the stalled condition.

Recovery, made by dropping the nose to a level flight attitude and adding power, resulted in very little loss of altitude. The lack of aerodynamic stall warning buffet necessitated the installation of a stall warning indicator which honks the automobile horn. All stalls were conducted in the "clean" configuration. The Aerocar is not fitted with flaps.

The Aerocar cruised at 100 mph. in level flight at a power setting of 2,450 rpm. Top speed in level flight is 110 mph. and V_{ne} is 130; plane is restricted from acrobatic maneuvers. The 23.5 gal. fuel tank of the Aerocar gives it an approximate still air range of 300 stat. mi. with no reserve at its fuel consumption rate of 8 gpm.

The Aerocar is intended to be, and is, a strictly VFR aircraft, the design philosophy being that when the weather is bad, drive it. Not only does the weight penalty of the automotive components (360 lb.) preclude the installation of gyro instruments and heavy radio gear, but the relatively slow cruise (100 mph.) and the 3 hr. endurance make it impractical to operate under instrument flight rules. The aircraft is equipped with navigation lights and the automobile headlights (low beam) can serve as landing lights. Glide tests were not conducted on the limited flight; however, it became apparent on landing that power-on approaches are necessary. Taylor recommended an approach power setting of 2,100 rpm. which brought the aircraft down a flat glide slope at 70 mph. indicated. Upon nearing the runway, a slight flare will slow the aircraft and establish a slightly nose-up landing attitude. At touchdown of the rear wheels, the throttle is chopped and directional control maintained with rudder until all four wheels hit the runway at which point the steering wheel becomes effective.

On landing, one must remember how low the Aerocar sits on the ground and take care not to flare out too high. Failure to do this on my part resulted in a nice test of the landing gear shock absorption system. The automotive type suspension (coil spring

Second Prototype Porter Demonstrated

Second prototype of Swiss-built Pilatus Porter multi-purpose transport plane is demonstrated over the Bernese Oberland (above). Aircraft now is available with either a Lycoming 275 hp. engine or a supercharged Lycoming 340 hp. powerplant. Plane can be converted to ski-wheel combination for glacier rescue work. Below, a group of packages make up a 1,100 lb. load for a typical rescue mission.

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You might be interested in some of the USS steels developed specifically for aircraft and missiles: USS Strux, an alloy steel with close to 300,000 psi tensile strength primarily for aircraft landing gears; USS Airsteel X-200, an air-hardenable alloy steel with 230,000 psi yield strength for aircraft sheet and missile applications; USS 12 MoV and USS 17-5 MnV Stainless Steels for high speed aircraft and missiles; Stainless "W", a precipitation hardenable Stainless Steel. Write for complete information about these remarkable new materials, and our revolutionary "sandwich" rolling technique for producing light gauge, wide alloy and stainless sheets. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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PASSENGERS, CARGO, OR MIXED LOADS – AW ARGOSY TAKES THEM ALL COMFORTABLY AND ECONOMICALLY

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The AW Argosy carries up to 83 passengers or 13¼ short tons of freight, or any combination within this payload. A typical mixed load would be over 7 tons of freight and 35 passengers. Rolls-Royce Dart turbo-prop power ensures a low noise level for the passengers seated in pressurised comfort. Large fore-and-aft freight loading doors reduce turnround to 20 minutes.
Components and systems are all well-tried and chosen for easy maintenance. Both passengers and freight can be loaded simultaneously.

PERFORMANCE *Power: 4 Rolls-Royce Darts. Aircraft cruising speed: (14,000 r.p.m.) 296 m.p.h. (475 km./hr.). Maximum payload: 27,000 lb. (12,247 kg.). Range with fuel reserves and 20,000 lb. (9,072 kg.) payload: 1,000 st.m. (1,610 kil.). Size of hold: 46 ft. 8 in. (14.23 m.) x 10 ft. (3.05 m.); floor area 426 sq. ft. (39.6 sq.m.).*

THE ARGOSY BRINGS THE COST OF AIR FREIGHT DOWN TO EARTH

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with shock absorbers), held up nicely.

Taylor demonstrated a hands-off landing, and while the aircraft headed for the side of the runway under the influence of a slight crosswind, it was easily straightened out when the front wheels touched down. The expander tube brakes are effective and slow the aircraft in a straight line. The company says that the Aerocar can be braked to a stop on landing in 300 ft. This was not tested, however, nor were crosswind landings.

Operating the Aerocar presents certain human factors problems in that one is apt to confuse the control actions of flying and driving. This confusion, while not unknown in conventional aircraft, is more likely to occur in the Aerocar since the cockpit environment is the same for both flying and driving. Common manifestations of this include using the brake while flying, grabbing the hand throttle to shift while driving, or in my case, attempting a takeoff with the automobile accelerator. Most of these aberrations are not dangerous. However, pilots should be cautioned against them, particularly when performing habitual actions.

To convert the Aerocar to an automobile, the wings are first unlocked by manually releasing two locking pins at either side of the cabin. Small trailer wheels are then cranked out of the wing roots and, after detaching the wing struts, the wings are folded back in the manner of the Grumman TBFs and F6Fs. With the wings folded in this manner, the shift in weight distribution causes the front wheels to be lifted from the ground. This is prevented by cranking a support rod out of the left wingtip which also serves to support the trailer when it is not being towed. The ailerons fold back over the upper wing surface to provide clearance for the horizontal stabilizer.

Three locking pins are unlocked to separate the wing and tail section from the auto. The prop shaft breaks at a spline, and the control cables separate at rocker assemblies requiring no connection or release.

The flight component trailer is 15 ft. long, 8 ft. high and 8 ft. wide; weight is 400 lb. The assembly is of all-aluminum construction as opposed to the glass fiber auto body. If the trailer is to be towed, it is turned around and connected to a trailer hitch which is fitted to the back of the car. The only tool required to remove or attach the flight components is a small hand crank that is carried in the car. Electrical interlocks on the five main locking pins prevent the starting circuit from being energized unless all five pins are driven.

Aerocar N103D is licensed as an automobile in the State of Washington. The company says that it will meet the Motor Vehicle Code in every state.

The vehicle, as an automobile, is a two-place car with a glass fiber body over an aluminum frame. The car has front wheel drive and is equipped with three speeds forward and reverse. Power is transmitted to the drive line through a fluid coupling and a multi-belt drive to the auto gearbox and drive shaft. The fluid coupling permits idling the engine in gear with the clutch out at rest; however this disengages the cooling fan and will overheat the engine if continued for any length of time.

The use of front wheel drive lessens the spin-up loads placed on the drive line upon landing touchdown.

The interior of the Aerocar contains many automobile appointments such as roll down windows, turn signals, and sun visors.

The car is started in the same manner as the aircraft, a 12 v. nickel cadmium battery supplying the power. The noise level of the air-cooled engine is rather high and is particularly startling for a car of this size. One of the design problems of the Aerocar was the development of a muffler which would satisfy Motor Vehicle Codes without creating too much back pressure in flight. Taylor says that four designs were flight-tested before the present expansion tube design was finally adopted.

Driving the Aerocar on the taxiways at Teterboro indicated that the car would provide adequate about-town transportation. Steering is quick and the brakes are excellent. Neither speed tests nor hill climbs were conducted, but the manufacturer claims a practical road speed of 55 to 60 mph. A slight wheel shimmy detected at about 45 mph. may have been peculiar to N103D.

In towing the flight components, low gear is used for starting. Otherwise the car is driven only in second and top gear. The car tows the trailer quite easily and the manufacturer's recommended maximum towing speed is 50 mph. The total length of the Aerocar when towing the trailer is 26 ft.

Empty weight of the Aerocar is 1,100 lb. The glass fiber body is used to reduce weight and even the fuel tank is glass fiber, with a gravity fuel flow to the engine.

Recommended fuel for the Aerocar engine is 80/87 octane aviation gasoline. Realizing that this might be difficult to procure when driving about town, the manufacturer has tested and recommends non-leaded automobile fuel as an alternate.

Gas mileage as an auto is 15 mpg.—a 350 mi. range.

The baggage space in the Aerocar is the area behind the seat over the engine.

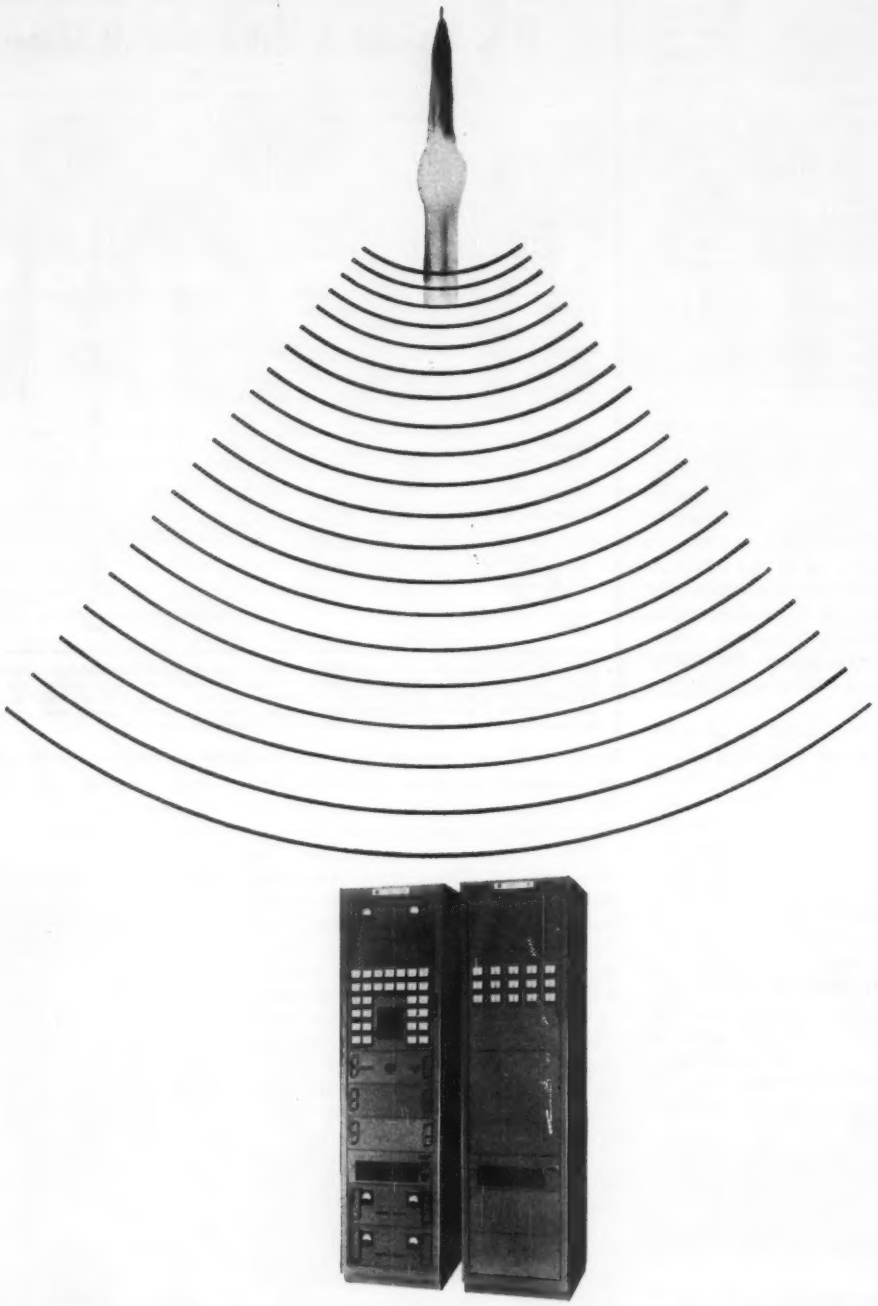
The successful flight characteristics of the Aerocar has led the company to design a four-place non-roadable model called the Aeroplane. The prototype of this aircraft is now under construction at Longview.

U. S. Business & Utility Aircraft Shipments

September, 1959

Manufacturer and Model	No. of Units	Net Billings
Aero Design 500	2	$856,000
560E	2	
680E	5	
720	1	
Beech 18S	8	$2,835,000
Bonanza	42	
Mentor	0	
Twin-Bonanza	4	
Travel Air	12	
Callair A5	0	$0
A8	0	
Cessna 150	39	$2,478,000
172	18	
175	24	
180	16	
182, Skylane	36	
310B, C	22	
Champion 7EC	1	$132,000
7FC	4	
7GC	13	
7HC	4	
Mooney Mk. 20	14	$172,000
Piper Super Cub	28	$1,452,000
Tri-Pacer	28	
Apache	11	
Comanche	46	
Pawnee	7	
Totals	385	$7,925,000

Note: In first nine months of Calendar 1959, business and utility aircraft manufacturers have shipped 5,615 aircraft having a net billing value of $97,532,000, compared with 4,725 aircraft having a net billing value of $76,460,000 in the same period last year—this despite a work stoppage due to a labor dispute at Piper Aircraft Co. in September, plus some slowdowns at several firms due to model changes. Even so, September showed some gain over the same month last year when 378 aircraft having a net billing value of $6,483,000 were shipped.



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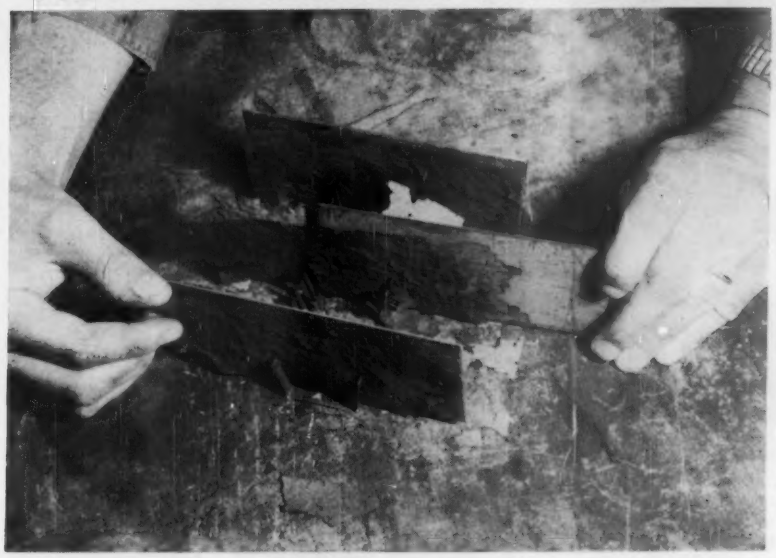


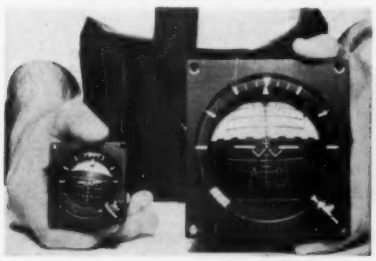
Heat-Treat Coating Forms Oxygen-Tight Seal

North American Aviation has developed a new coating for metal which eliminates the necessity of providing an inert gas atmosphere to prevent scale formation during heat treatment. Tradenamed "Skalix," the coating is applied by spraying or dipping and forms an oxygen-tight seal at furnace temperatures. H. A. Storms, chief engineer at North American's Los Angeles Division, said the coating has uses in heat treating stainless steel, nickel-chrome alloys, cobalt alloys, copper alloys and new exotic alloys now under development. Aside from eliminating the need for an inert atmosphere and the attendant cost of such a method, Skalix spalls off the metal surface as it cools, leaving the surface free of scale and, in some instances, requiring no further treatment.

Gyro Attitude Indicator

Remote vertical gyro indicating system fits in a standard 2 in. square cockpit panel cutout and is intended as a standby unit to replace an aircraft's primary system in the event of a malfunction.

Pictorial indicator, Model 4012, displays pitch and roll attitude by movement of a light grey and optical black



sphere behind a fixed, symbolic aircraft.

A 1.5:1 gearing in the pitch axis provides increased sensitivity of the pitch attitude. Indicator is hermetically sealed and includes two miniaturized transistor amplifiers. The servo loops are 70% critically damped; the two amplifier modules are identical and interchangeable.

Lear, Inc., Grand Rapids, Mich.

Rocket Insulators

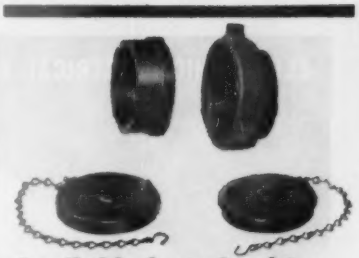
Rubber sleeve insulators are used to insulate the outer case from the solid fuel of rockets and missiles.

The sleeve prevents the solid propellant from burning through the motor casing, thus causing failure of the rocket. The insulator will be used on the Polaris and Minuteman missiles, and is in use on the Terrier, Tartar and Talos booster.

Garlock Packing Co., Palmyra, N. Y.

Missile Ball Valves

Ball valves, operating at 10,000 psi. pressures, are designed for missile



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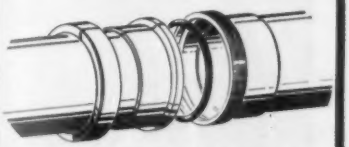

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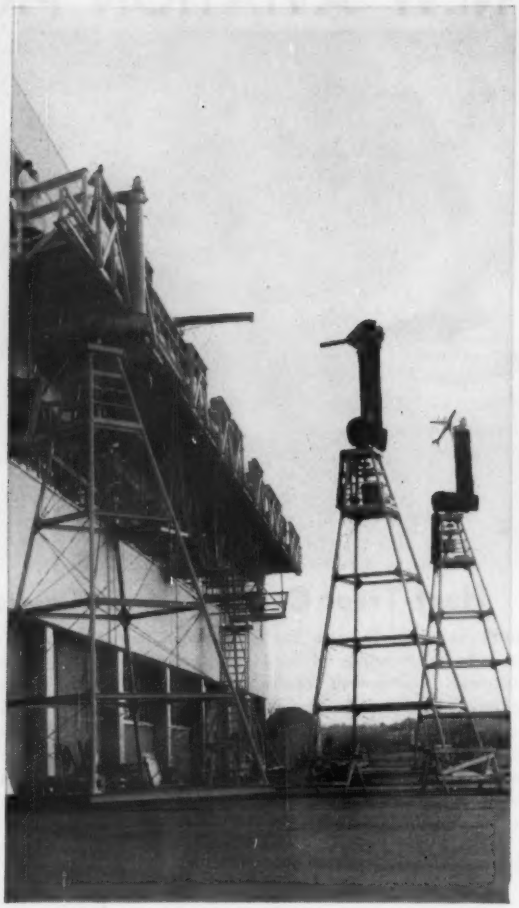

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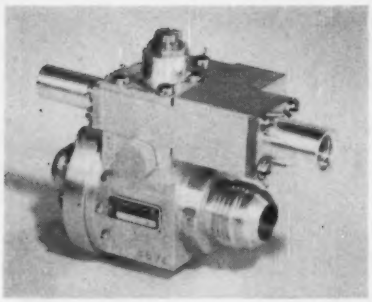

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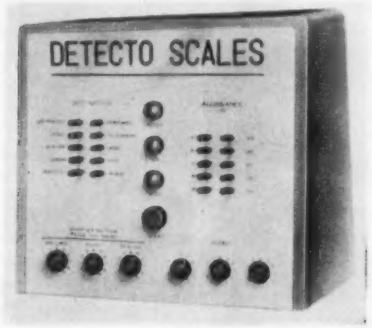

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Detecto Scales, Inc., 540 Park Ave., Brooklyn 5, N. Y.

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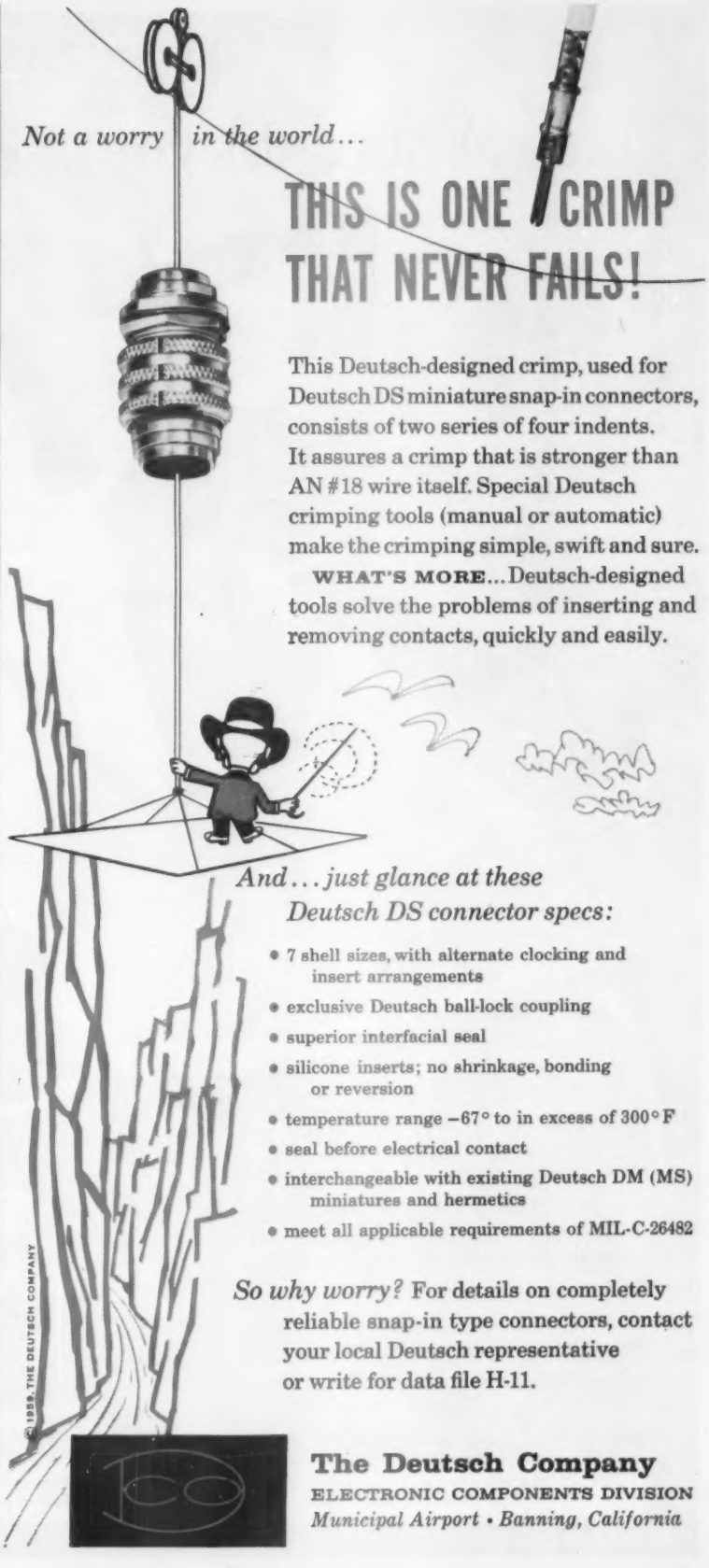

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So why worry? For details on completely reliable snap-in type connectors, contact your local Deutsch representative or write for data file H-11.

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Constant laboratory research and testing of rocket components, such as the valve above being subjected to simulated flight conditions, assure highly reliable performance from Thiokol rocket motors and engines

320°F?

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In picture left, liquid nitrogen flowing through a turbo pump valve of a type used on the powerplant for the Air Force's X-15 drops the temperature within the valve to minus 320°F. This is slightly cooler than in actual operation, when the valve will pump highly combustible liquid oxygen (minus 297°F) and ammonia.

Laboratory tests are an essential part of the continuing research program in new materials, new design and new fuels, carried on by THIOKOL's rocket builders. In close support are the scientists of THIOKOL's Chemical Division, who continually seek new properties for their liquid polymers to meet increasing performance demands.

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THIOKOL plants are located in areas that are good places to live—Bristol, Pennsylvania; Elkton, Maryland; Huntsville, Alabama; Marshall, Texas; Denville, New Jersey; Trenton, New Jersey; Brigham City, Utah; Moss Point, Miss. For further information contact: Personnel Director at any plant address above.

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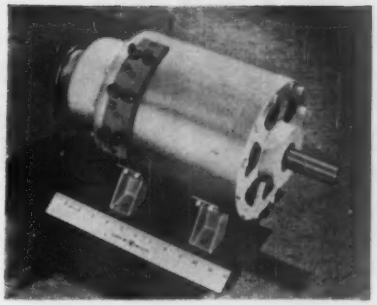

ous duty, and a 15 hp. continuous duty motor. All motors operate on three phase, 115/200 v., 400 cps. power, and meet the environmental requirement of MIL-E-5272C.

AiResearch Manufacturing Division, 9851 Sepulveda Blvd., Los Angeles, Calif.

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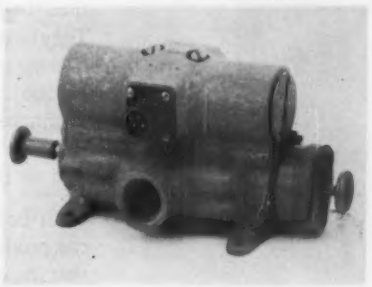
Solenoid operated hydraulic selector valve is available in two versions.

HP 348100 is a four-way, three position, spring loaded to neutral valve solenoid with optional manual overrides. This unit is qualified per Mil specs for use in a 3,000 psi., −65 to 275F hydraulic system. Production



models are available in −4, −6, and −8 line sizes, using forged aluminum bodies with hardened 440C stainless steel spools and sleeves. Model HP-574100 is a two-position spring loaded version.

Hydra-Power Corp., Pine Court, New Rochelle, N. Y.

Ultrasonic Flaw Detector

Ultrasonic flaw detector suitable for both contact and immersion inspection

techniques can be directly mounted on scanning bridges now in use.

The UI reflectoscope has a 12 in. dual trace display tube and a two-color display which permits flaws to be readily distinguished from range marks. Frequency ranges of the unit run from 1.0 to 25.0 mc., weight is 100 lb., and the unit measures 18 x 15 x 21 in. The repetition rate is variable from 200 to 2,000 pps.

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Sperry Products, Inc., Shelter Rock Road, Danbury, Conn.

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Conversion Charts for Time-Temperature Parameters for converting stress-rupture test data to a parameter, Westinghouse Aviation Gas Turbine Division, Dept. T-331, 95th & Troost Streets, Kansas City, Mo. . . . Diagrams, performance details, photographs, and operating principles of the **Exploding Bridgewire System** for initiating missile and space vehicle ordnance functions, EBW brochure, Kenneth Johnson, Librascope/Sunnyvale, 670 Arques Ave., Sunnyvale, Calif.

Encapsulated Transformers, brochure, describes performance characteristics and applications of patented HR/Epseal and Electroseal transformer constructions, Electro Engineering Works, 401 Preda St., San Leandro, Calif. . . . Curves and tables, applications and characteristics of **Series 2200 Microbon Ribbon** fluid filter elements, Brochure No. 44, Bendix Filter Division of Bendix Aviation Corp., 434 West 12 Mile Rd., Madison Hgts., Mich.

Detailed description of the **Model 102 lightweight, turbine-driven fuel pump,** catalog sheet, Sales Dept., Santa Barbara Division, Curtiss-Wright Corp., 6767 Hollister Ave., Goleta, Calif. . . . **Adhesive Bonding of Aluminum,** booklet, Reynolds Metals Co., Dept. PRD-21, Richmond 18, Va.

Ohmite Components for Military Applications, Catalog No. 50, contains summary charts, dimensional drawings and derating graphs of value to development engineers, Ohmite Manufacturing Co., 3675 Howard St., Skokie, Ill. . . . **Properties of Ti-4Al-3Mo-1V,** Titanium Engineering Bulletin No. 8, gives design data on heat treatable titanium sheet alloy for minimum-weight high-speed aircraft, Titanium Metals Corporation of America, 233 Broadway, New York 7, N. Y.

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Hawthorne, California

CAB Accident Investigation Report:

Turbulence Blamed in Viscount Breakup

About 1613, May 12, 1959, Capital Airlines Flight 75 disintegrated in flight over an area near Chase, Md. All occupants, four crew and 27 passengers, were killed. The aircraft, a Vickers-Armstrongs Viscount, N 7463, was destroyed.

From all of the available evidence the Board believes that the in-flight disintegration was caused by aerodynamic loads imposed on the aircraft which exceeded its design strength and which were generated by an excessive airspeed combined with turbulence and maneuvering loads (AW Nov. 2, p. 30). Based upon the evidence, the Board concludes that there was a loss of control in extreme turbulence in the area of thunderstorms and, after a steep involuntary descent during the subsequent recovery, loads beyond the design strength of the aircraft occurred.

Following the preparations for Flight 75, Capital Airlines dispatch had received additional weather information affecting the route of flight. This information was the first that delineated the location of a potential squall line along the route and indicated that the severity of thunderstorms along the line was increasing. Although it was known that Flight 75 did not have the assistance of operable radar no action was taken by dispatch to ensure that the flight had received this information. The Board considers this information would have been valuable to the flight.

INVESTIGATION

On May 12, 1959, Capital Airlines Flight 75 was scheduled from La Guardia Field, New York, to Atlanta, Ga., departing at 1500[1] and arriving at 1755. The assigned crew was Capt. W. C. Paddack, First Officer M. J. Flahaven, and Hostesses D. Gulick and S. Wessell. Company crew histories, training records, and recurring proficiency checks showed the crew members were properly qualified and certificated for their respective positions. Capt. Paddack had flown more than 22,000 hr.

The day of the accident, N 7463 was originally scheduled for Trip 79; however, writeups that the No. 2 engine operated with an excessive tailpipe temperature required it be removed from the assignment to change the No. 2 fuel control unit and high pressure fuel pump. This work corrected the trouble and was completed early in the afternoon. The plane was then rescheduled to operate as Trip 75 and serviced to 14,500 lb. of kerosene and 60 gal. of water-methanol.

A review of the company service and maintenance history indicated the aircraft had been maintained properly and was in an airworthy condition for Trip 75. The airborne weather radar was inoperative; however, it was not a required item under existing regulations or by company policy.

Capt. Paddack and First Officer Flahaven arrived at La Guardia about 1240 as the pilots of Capital Flight 220 from Detroit. Evidence obtained during investigation revealed they remained at the airport between flights and that they seemed to be in good health and spirits. Both were observed in and about the crew lounge and engaged in the preparations for Trip 75. Capt. Paddack spoke with ground personnel about the maintenance work on N 7463 and was later seen watching the plane being serviced. The first officer was observed just before flight time walking around the aircraft, obviously preflighting it.

Flight Delayed

Flight 75 taxied away from the terminal at 1520, 20 min. late. The last-minute delay occurred when Capt. Paddack found an error in the aircraft gross weight computation and questioned the weight for the existing runway restriction. At 1455 the flight radioed for runway temperature. The senior operations agent came aboard and he and the captain rechecked the computations to make sure the weight was correct and below maximum allowable for the runway length, the existing surface wind, and temperature. The problem was satisfied and it was determined that the gross weight was 60,507 lb., 103 lb. less than the maximum allowable of 60,610 lb.

During taxi, Flight 75 was issued an instrument clearance according to an instrument flight rules flight plan filed earlier. At 1529 a normal takeoff from runway 22 was observed. Executing the clearance, Flight 75 made numerous radio communications in the New York area and proceeded uneventfully to its assigned cruising altitude, 14,000 ft., and onto the assigned airway, Victor 3. Regular position reports were made as the flight progressed.

At 1602 Flight 75 contacted the Washington Center. It reported that it was over Westchester on the hour, 1600, at 14,000, estimating Westminster at 1617, with Herndon next. In the same message it advised, ". . . ah, we've got a pretty good string of thunderstorms along that course . . . ah, if we could stay in the clear and stay a little bit south of Westminster, is that O. K. with you?" The center controller replied, "Capital 75, that'll be all right and report passing Westminster." The flight acknowledged. At 1610 the flight advised, "Ah, Washington Center, this is Capital 75, we've reduced to one seven zero knots account rough air." This was the last message from the flight on the center recorders and the last which could be determined as having been made.

Witnesses Report

More than 100 eyewitnesses to the accident were interviewed and most provided written accounts of their observations. It was immediately evident that most were attracted by the in-flight breakup itself and comparatively few saw the aircraft both before and during the in-flight disintegration. With so many accounts, some varied or could not be correlated with a preponderance of other information. The majority, however, were consistent with other phases of the Board investigation and provided valuable information.

According to the evidence, just prior to the disintegration the aircraft was flying southwest at an altitude estimated as between 3,000 and 7,000 ft. A majority believed it was flying in a straight and level attitude and at a normal speed. At the time of disintegration it was in a clear area between clouds and near large thunderstorm buildups.

Of those who saw the aircraft just before and during the breakup one was attracted by a loud engine or propeller noise, another said the sound was surging. Several saw a fire just before the breakup. Two placed it near the right wing root, another on top of the cabin, and another just in front of the tail. Most, however, said the only fire was a large flash explosive fire that occurred simultaneously with the in-flight disintegration. At least three eyewitnesses said the aircraft was struck by lightning and then it exploded; a majority held that no lightning was involved.

Observers were most consistent that the right wing separated first, and instantly thereafter the remaining aircraft structure broke into three major sections. All agreed that most of the pieces fell to the ground in flames.

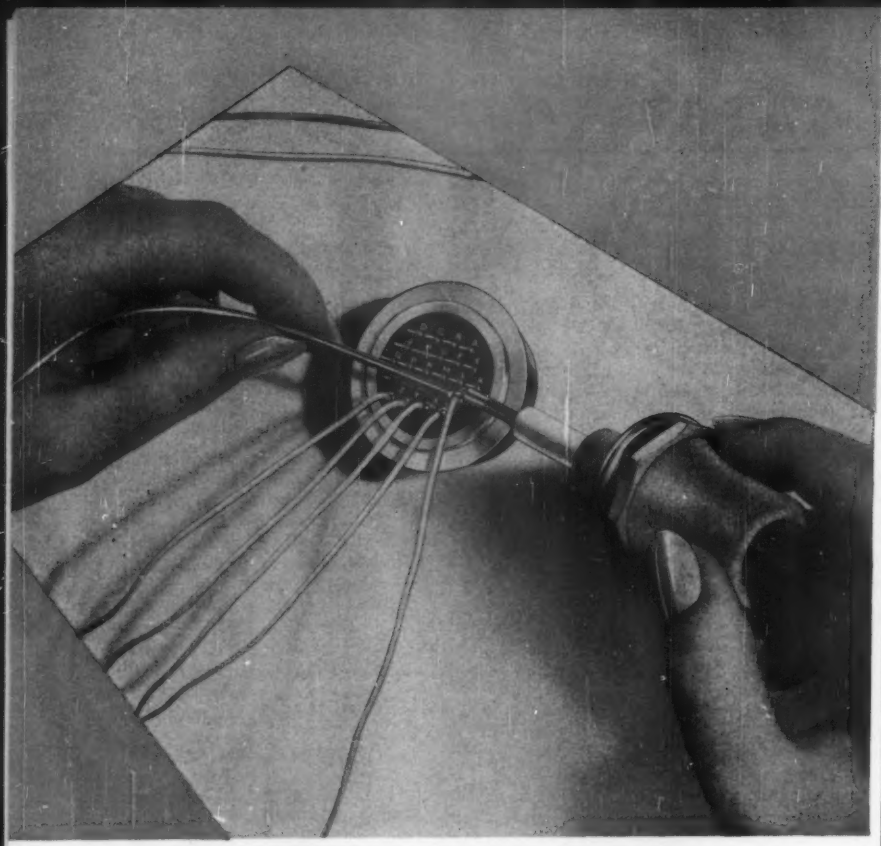
From those witnesses who could relate the accident to a specific time reference it was reliably determined that it occurred very close to 1613.

Breakup Altitude

Since most who saw the aircraft break up estimated it was between 3,000 and 7,000 ft. when it disintegrated instead of 14,000 ft., the assigned and last reported altitude, a flight test was made to determine the approximate altitude. A Capital Viscount was flown several times along the probable flight course of N 7463, at different altitudes from 3,000 to 14,000 ft., while 11 eyewitnesses watched from their original positions. Each designated the pass on which the altitude of the test plane was closest to that of N 7463 when it disintegrated. The result averaged 5,500 ft.

The main wreckage was located about 2 mi. northeast of Martin Airport near Chase, Md. The area is 49 naut. mi. from the Westchester omni on a magnetic heading of 236 deg. The heaviest portions of structure were found concentrated in a localized area showing an instantaneous breakup of most of the aircraft, although many lighter and smaller pieces were drifted by northwest winds and deposited along a southeast path about 2½ mi. long. Some of this latter structure fell into swamp and heavily wooded areas and some into shallow inlets of Chesapeake Bay. An exhaustive search,

[1] All times here are Eastern Standard based on the 24-hr. clock.



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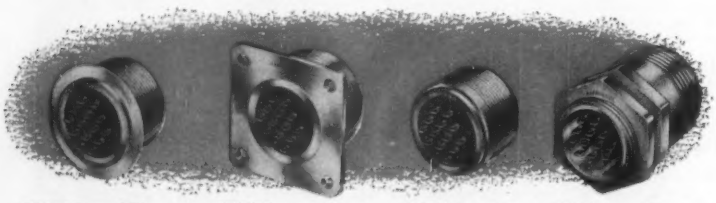

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greatly assisted by several civil and military organizations, resulted in recovery of about 90% of the aircraft structure which was then moved to a hangar, laid out, and given meticulous examination.

The empennage structure was localized about one mile southeast of the main wreckage concentration. Examination of this structure showed both the left and right horizontal stabilizers failed downward along a chordwise line near the No. 2 elevator hinge. The stub end of the left stabilizer was torn from the fuselage by forces predominantly rearward and downward. The remaining portion of the right stabilizer remained attached to the fuselage; however, the lower surface was wrinkled in the area adjacent to the fuselage. The upper surface was wrinkled at the root just forward of the spar and the wrinkle continued into the aft fuselage. Both elevators were torn off in sections by forces causing failures at the hinge points. The vertical fin was torn off by forces predominantly to the left. It separated, tearing with it part of the fuselage attachment frame at station 870. The rudder separated from the fin at the hinge points and was broken into four sections, one of which was not recovered.

Fire Evidence

The empennage surfaces were unmarked by fire but fuselage structure located immediately ahead was heavily sooted by fire.

The right wing separated in flight. It broke downward along a chordwise line near the wing root. This wing panel fell in flames, was damaged by ground impact, and partially consumed by fire.

The left wing outer panel separated in flight along a chordwise line in the area of the No. 1 engine nacelle. This panel separated from forces that failed the wing spar forward. Between the No. 1 and 2 nacelles the wing panel was broken into several sections, the spar was bowed downward, and the upper wing skin was failed by tension loads. Near the inboard fracture line the wing spar failed rearward. The stub end of the left wing and wing center section remained attached to the center fuselage. Evidence showed that the left wing separation and breakup, which tore open fuel cells, was accompanied by an intense flash fire. The left outer wing panel fell in flames and continued to burn on the ground until it was nearly consumed.

Gear, Flaps Up

The landing gear was retracted and locked; flaps were up.

The fuselage broke up in flight into three principal sections. These, in general, were the cockpit and forward passenger cabin, the cabin rearward to the last row of seats, and the aft fuselage from the last row of seats to the area below the vertical stabilizer. Much of the fuselage shell and overhead structure tore away in small pieces. These were found scattered over the full 2½ mi. long wreckage path.

Examination of all passenger seats, except one not recovered, showed they had been subjected to positive loads. Because these were opposite to the loads imposed on the seats during breakup, they obviously occurred earlier.

Nearly the entire left side of the fuselage was sooted by fire and in areas of the

heaviest deposits paint was blistered. Study showed this occurred after many pieces tore away because some pieces normally located next to those that were sooted were clean. Comparatively, the right side of the fuselage showed little exposure to fire.

In other areas of in-flight fire damage there was much evidence of a flash fire during the breakup; there was no evidence that a fire or explosion preceded the distintegration. The wreckage was also examined for evidence of a lightning strike. It was not possible to conclude that lightning did not strike the aircraft; however, it was conclusively established that there was no significant damage to the aircraft as a result of a lightning strike.

All four powerplants separated from the aircraft about the same time and fell reasonably close to each other in the main wreckage area. Examination showed that the nacelles failed at their attach point to the wing as the result of uploads, although downloads had occurred prior to separation. The latter caused damage to the propeller reduction gearing assemblies and to the "W" struts.

No Malfunctions

Examination revealed nothing which indicated malfunction or failure of the engines prior to the breakup sequence. There was no indication of operational distress, inadequate lubrication, or overheating. On the other hand, there were clear indications that all of the engines were operating when they tore off. The No. 2 and 4 fuel-trimmer actuators were positioned for reduced power.

Each propeller, except No. 3, was found attached to its respective engine. No. 3 separated in flight and was found about 775 ft. from its engine. Examination indicated separation occurred when the No. 3 propeller blades struck a heavy object during the in-flight breakup. This gouged the blades and caused a torsional failure of the engine reduction gearing coupling shaft. The blow also caused an elongation of the propeller blade operating dowel pin holes at a position which showed a propeller blade angle of 52 deg.

At ground impact the No. 1 propeller blades were positioned about 24 deg.; No. 2, about 29 deg.; No. 3, about 6 deg.; and No. 4, 16 deg. Propellers No. 3 and 4 were in the ground fine pitch range. These positions, because of the numerous safeguards that prevent ground fine pitch from occurring in flight, were determined to have resulted from free fall and impact forces. Consequently, only the blade angle of the No. 3 propeller was considered valid and significant.

A review of the original certification process for the British-manufactured Viscount showed it was built to conform to the British Civil Air Requirements and issued a British airworthiness certificate. The Federal Aviation Agency, then CAA, reviewed the specifications and requirements and, when satisfied that an adequate standard of airworthiness existed, accepted the British certificate and issued the aircraft the U. S. airworthiness certificate. This process was carried out under the terms of Executive Agreement 69 of Oct. 17, 1954. It was stated by both representatives of the British and U. S. that the strength requirements of each country are about the same and the Viscount met or exceeded both.

The recommended rough air penetration speed for the Viscount is about 170 kt., the last airspeed reported by Flight 75. At or near this speed the aircraft strength is sufficient that extreme maneuver and/or gust loading will stall the aircraft rather than cause a structural failure.

Autopsies were performed on all of the crash victims according to provisions of the law of the State of Maryland. At the public hearing the Chief Medical Examiner testified relative to the findings in order that the Board could avail itself of every facet of information relevant to the accident. The findings indicated that all of the occupants of the plane were killed by impact with the ground, although about 20 passengers had sustained ante-mortem injuries. The majority of the ante-mortem were described as scalp injuries of the type and degree which suggested heavy bumps on the head by contacting overhead structure.

Others were seat belt injuries and two or three suggested forces applied downward on the body forcing it into the passenger seat. The findings showed that some passengers were exposed to an intense flash fire which contained droplets of flaming liquid. At least 10 passengers revealed an elevated level of carbon monoxide; the highest was about 10%, not normally a disabling amount. The medical examiner said the time required to attain the levels found was difficult to determine. Depending on several factors, the time could vary from eight seconds to several minutes. He indicated that the relatively few bodies showing carbon monoxide was consistent with a short period of exposure during which some passengers were affected while others in the immediate area were not. The medical findings indicated none of the persons was struck by lightning.

The findings indicated the pilots had no pre-existing physical condition which would impair normal duties and nothing suggested that pilot incapacitation was a factor in the crash.

Board investigators found no evidence in the medical information that was inconsistent with the physical examination of the aircraft. In fact, the information was in accord with evidence found during other phases of the accident investigation.

At 1600 a cold front existed along a line from Philadelphia to Baltimore to near Gordonsville, Va. Regional forecasts issued by the Weather Bureau in Washington at 0700 and 1300 and the area forecast[2] issued by the Weather Bureau at Idlewild at 1400 drew attention to the possibility of locally severe thunderstorms and extreme turbulence associated with the front. The front was forecast to be virtually stationary. The 1400 area forecast also stated there was the possibility of a squall line development in advance of the front.

At 1415 the Idlewild Weather Bureau office issued the following flash advisory.[2] "Line of scattered thunderstorm activity near Martinsburg-Harrisburg-Poughkeepsie northeastward is moving eastward about 20

[2] Volume 3 of the Weather Bureau Manual states: "Flash Advisories deal solely with potentially hazardous weather within a period of 2 to 4 hr. in advance while Aviation Area Forecasts include potentially hazardous weather plus other operationally significant weather for a period of 12 hr. plus an outlook for the next 12 hr. . . . Flash Advisories will automatically amend the outstanding Aviation Area Forecasts for the period of the Flash Advisory."

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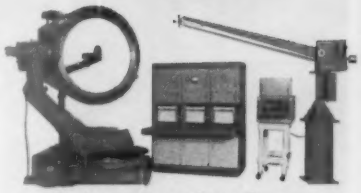

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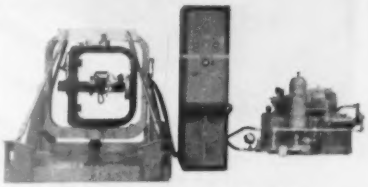

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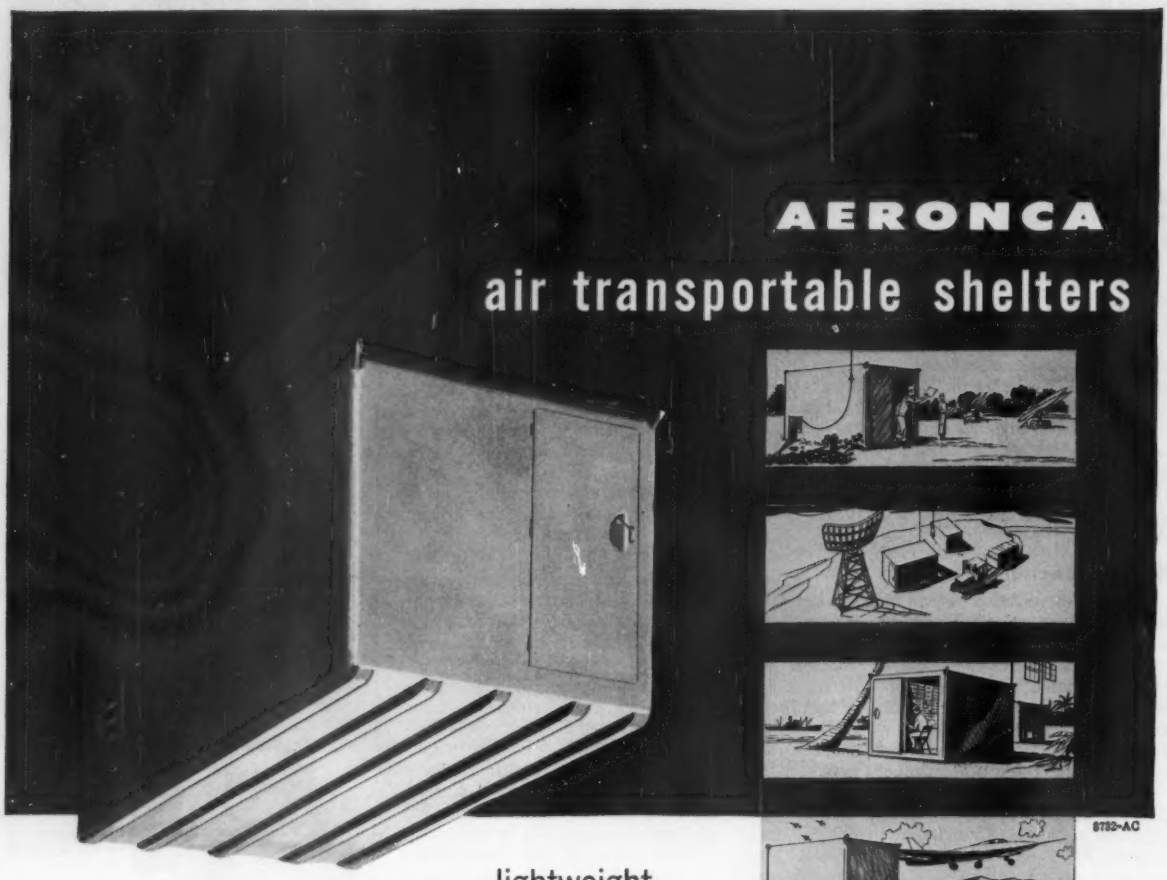

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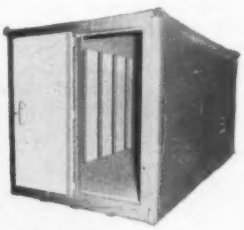

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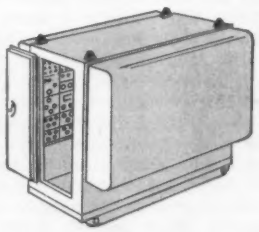

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kt. accompanied by severe turbulence and conditions locally below 1,000, visibility 2 mi.

This line will move to near Providence-New York City-Philadelphia by 1800 increasing in intensity during afternoon. Valid until 1815." The Capital meteorologist located in Washington marked off the areas covered by the advisory on a blackboard chart located on one wall of the dispatch office. The advisory was also available on the teletypes at the dispatch sectors positions in the office.

During the afternoon, radar reports were issued about hourly from Andrews AFB weather. These reports described the locations of the thunderstorms and indicated they were increasing in intensity during the afternoon along the New York-Washington route of Flight 75. These reports were also on teletype machines located in Capital dispatch at the sector positions.

About 1548 the cold front passed the Baltimore-Chase area. It was indicated by a pronounced wind shift in about two minutes, a pressure jump of .08 in. of mercury in 20 min., and wind gusts to about 45 kt.

According to the Civil Air Regulations and the Capital Airlines Operations Manual, dispatch may cancel or divert a flight on the basis of existent or anticipated adverse weather conditions. The captain of a flight has this authority and under emergency conditions may take such action as he considers necessary in the interest of a safe operation. Dispatch is also required to furnish the en route pilot any additional available information concerning meteorological conditions which may affect the safety of a flight.

No action was taken by dispatch to furnish the flash advisory or radar information to Flight 75. Dispatch did not know if Capt. Paddack had received the advisory prior to departure. It was stated by dispatch personnel that they believed the flash advisory indicated improved conditions over those previously forecast and that all of the weather data indicated the thunderstorms were scattered, thus circumnavigable.

With respect to providing an en route flight weather information, one dispatcher said, "If the trip is operating in a scattered thunderstorm condition, the likelihood of any extended period in solid cloud is almost negligible. If he is operating where you would expect solid IFR conditions, it is a condition that requires all of the information he can get." It was stated that because many Capital aircraft are not radar-equipped there was no distinction in the information furnished the en route flight based on this equipment.

Following the accident, a study of the weather conditions prevailing in the accident area at the time of the accident was made by a U. S. Weather Bureau research meteorologist. The results of this study showed there were large rapidly developing thunderstorms in the vicinity of Martin Airport, located about 2¼ mi. southwest of the accident area. Utilizing several techniques it was also determined that extreme turbulence[3] most probably existed at 14,000

[3] Extreme turbulence is defined by NASA as a rarely encountered turbulent condition in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage.

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Each staff member is provided with every opportunity, facility and detail of environment to use his creative and analytical skills to maximum advantage and at the highest level. He has no responsibility for administrative details. He can call in any specialists he may need. He has full access to all available information—military, academic and industrial. Furthermore, specialized research projects and laboratory work can be carried out at his request by other departments of RCA.

THE MEN—The men who form the technical staff are a group of mature scientists and engineers. They are accustomed to responsible positions in industrial research, advanced development, or systems planning. Most of them have an extensive background in the broad fields of electronics, vehicle dynamics (space, marine or terrestrial), physics (astro, nuclear, or plasma), or operations research (military science). All are men who enjoy seeing the fruits of their work have a far-reaching effect on the defenses of the country.

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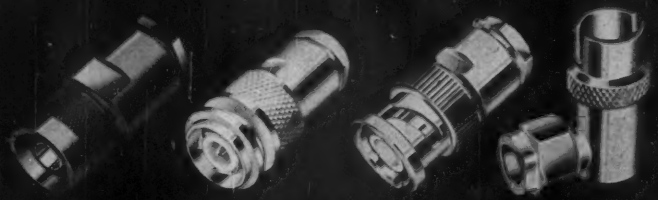

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ft. in the thunderstorm cells and areas around them. It was also shown that extreme turbulence may exist not only in the thunderstorm cell but up to five miles around it.

The pilots of another Viscount observed Flight 75 deviate at the Westchester omni. At that time these pilots, using radar, noted no indications of severe thunderstorm cells on airway V-3. Consequently, they continued on the airway and experienced no difficulty. An executive pilot also stated that from a location north of the accident scene he observed a severe thunderstorm cell on airborne weather radar near the accident scene. He described it as twice as strong as any other in the vicinity. He immediately altered course to avoid it. Still another pilot operating according to visual flight rules reversed course in the accident area to avoid instrument conditions of a thunderstorm.

ANALYSIS

On the basis of all the available evidence it is the Board's analysis that the in-flight disintegration occurred as the result of loads imposed on the aircraft which exceeded its design strength. It is the Board's opinion that the forces were from a high indicated airspeed in turbulence. The Board believes that this airspeed was generated during an involuntary descent from 14,000 ft. which followed loss of control of the aircraft in extreme turbulence. The Board is convinced that no pre-existing weakness or condition contributed to the breakup and that no malfunction or failure of the aircraft, its systems, or its components led to the circumstances under which the disintegration occurred.

From examination of the major fractures, breakup patterns, and from design considerations it is believed that the initial failure in the destruction sequence was the nearly simultaneous downward failure and separation of the horizontal stabilizers at the No. 2 hinge points. This is confirmed by the fact that the symmetrical stabilizer failures could only occur with both wings intact. Also, under ultimate loadings on the aircraft the stabilizers would be expected to fail first. Furthermore, the breakup sequence and the nature of the mass of fractures are entirely consistent with this as the initial occurrence.

Following separation of the right and left stabilizers the aircraft pitched down violently so that all four nacelles broke upward from combined inertia and gyroscopic loads. Immediately thereafter both wings were subjected to extreme downloads under which the right separated and the structural integrity of the left wing was destroyed. With the nacelles, right wing, and stabilizers gone, drag induced by the left wing yawed the fuselage violently to the left. Forces to the left tore off the vertical fin with portions of the fuselage attached, the latter already weakened when the left stabilizer stub tore away. During the subsequent gyrations the left wing broke up, its fuel cells were opened, and the flash fire occurred. At the same time the remaining fuselage disintegrated. The Board believes that the major disintegration sequence took less than one second and that during the latter part of the sequence occupants of the plane were exposed in a random manner to the flash fire and attendant high concentration of carbon monoxide.

The high indicated airspeed which the Board believes existed at breakup is suggested by several singular factors which, in their cumulative value and with the overall patterns of evidence, make the existence of excessive speed nearly irrefutable.

An important consideration is that unless an airspeed in excess of cruising was present the strength of the Viscount is such that forces causing the horizontal stabilizer failures which occurred cannot be developed. Below cruising speed the horizontal tailplanes will stall at loadings less than those necessary to cause failure.

The high indicated airspeed is also suggested by the structural damage to the passenger seats, propeller reduction gearing assemblies, the engine mount "W" struts, and possibly by the ante-mortem injuries to two or three passengers. The damage and the injuries resulted from pullup loads which were in the opposite direction to the loads imposed on these subjects by the breakup forces. This damage had to be made prior to the breakup and is compatible with a descent in which high speed was attained, followed by a recovery in rough air in which positive "g" forces had to have occurred.

A further indication of an excessive airspeed and one more definitive of the amount was the blade angle of the No. 3 propeller, 52 deg. It is believed the indications of blade angle were made during breakup, therefore, airspeed calculated from the blade angle would be valid at that time. From technical data relating to airspeed and propeller blade angles it was shown that with the 52-deg. angle there is no throttle position at which true airspeed could be less than 295 kt. Because this airspeed is excessive it is entirely logical to assume the throttles would have been closed to slow the aircraft. With the throttle closed a 52-deg. blade angle reflects a true airspeed of 335 kt., which is 15% in excess of the Viscount never-exceed speed or about 5% in excess of V_D, the maximum speed demonstrated in certification. Loads at such an airspeed, combined with gust and/or maneuvering load, could easily exceed the strength of the aircraft.

Involuntary Descent

From the evidence of a high airspeed, combined with pullup forces already discussed, it is the Board's opinion that an involuntary descent occurred before the in-flight disintegration. The foregoing conclusion is supported by the fact that the breakup occurred at about 5,000 ft. and it is not reasonable, under the circumstances, to believe that a voluntary descent would have been made. The configuration of the aircraft at breakup—gear up and flap retracted—is also inconsistent with a voluntary descent under the turbulent conditions known to have existed. Finally, believing that Flight 75 was at 14,000 ft. about 1610 and that the aircraft disintegrated some 5,000 ft. above the terrain about 1613, a descent of 9,000 ft. in three minutes or less is evident. Again, a descent occurring under these factors of time and altitude would not be less than 3,000 fpm. and not less than V_{ne}. This evidence serves to confirm the aforementioned speed indicated by the propeller blade angle.

The evidence clearly shows the existence of large, rapidly developing thunderstorms in the area of the accident and that extreme turbulence most probably existed in and around the thunderstorms. From all evidence the Board firmly believes extreme turbulence was encountered and a loss of control occurred resulting in an involuntary steep descent. During the final stages of the recovery loads in excess of design strength were imposed on the aircraft causing disintegration.

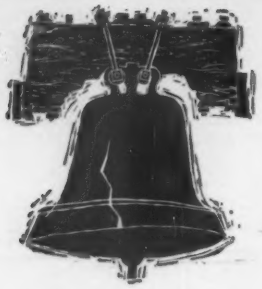
The Board knows of no evidence in this accident from which it can determine the sequence of events and factors immediately attending the situation in which loss of control of the aircraft occurred at 14,000 ft. Such factors may be numerous and varied. The Board recognizes the possibility that Capt. Paddack may have been attempting to cross the line of thunderstorms to re-establish the flight on V-3 airway. In doing so he may have selected an opening in the thunderstorms which closed causing loss of visual reference and then entered a thunderstorm which was obscured. It is considered possible under a similar occurrence that Capt. Paddack attempted to maneuver out of such a situation and placed the aircraft in a turning configuration in which the aircraft could more easily be placed in a unusual attitude and in which control techniques would be more critical. Under any consideration the pilot's technique and psychological approach to thunderstorm penetration are important factors. In its considerations the Board was also unable to rule out with complete definitiveness the possibility of a cockpit distraction or instrument failure at a critical moment.

No Advisory

Because Flight 75 was released at 1435 with 1400 weather attached to the release and because the crew was apparently at the aircraft considerably before flight time, the Board believes that Capt. Paddack did not receive the 1415 flash advisory. While the flight was en route no action was taken to ensure the flight had this information or to provide it with available radar information concerning thunderstorms along the route. The advisory would have delineated the position and movement of the line of thunderstorms along the route and would have indicated that they were expected to increase in intensity. Radar information could have indicated the individual positions of the thunderstorms. While it is not possible to state the action Capt. Paddack would have taken had he received the information the Board believes it would have supplemented substantially what he could see, thus providing him with more information on which to base his decisions. Certainly, according to the carrier's operations manual, this information fitted the description of information which should be furnished a flight.

CONCLUSIONS

From all the evidence, the Board concludes that Flight 75 deviated at the Westchester omni to circumvent thunderstorms which were visible on the airway of intended flight. At 14,000 ft. and at reduced airspeed a course of about 240 deg. was followed which closely paralleled a line of thunderstorms associated with a cold front. The Board concludes that the flight penetrated an area of extreme turbulence in the



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immediate vicinity of a severe thunderstorm which resulted in loss of control of the aircraft. This resulted in an involuntary descent during which high airspeed was generated. Aerodynamic loads from the airspeed, recovery, and turbulence then exceeded the design strength of the aircraft, causing it to disintegrate.

The Board concludes that Capt. Paddack did not receive the 1415 flash advisory prior to departure and that dispatch did not pass this and other available weather information to him en route. It is believed that the information would have materially assisted the captain in his appraisal of the situation and thereby given him more information on which to base his operational decisions. From this nonaction the Board must conclude that Capital dispatch did not asssist the pilot to the ultimate of its capability.

The Board fully recognizes that there are many factors in adverse weather phenomena that are difficult to assess accurately. The Board has therefore advocated every practical asssistance to pilots transporting the public. The Board believes that aircraft radar has proved to be such an assistance, particularly in modern high-performance aircraft. While it is impossible to predict precisely the action which would have been taken by the captain had the airborne radar been operable, there is evidence to indicate the likelihood that the area of turbulence could have been avoided through the use of airborne radar. The Board therefore concludes that the provision of airborne radar on such aircraft would enhance aviation safety.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was a loss of control of the aircraft in extreme turbulence resulting in an involuntary steep descent following which aerodynamic loads from high airspeed, recovery, and turbulence exceeded the design strength of the aircraft.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident shortly after occurrence. Investigators were immediately dispatched to the scene and an investigation was conducted in accordance with the provisions of the Federal Aviation Act of 1958. A public hearing was held in the Southern Hotel, Baltimore, Md., on July 8, 9, 10, 1959.

Air Carrier

Capital Airlines, Inc., is a Delaware corporation and maintains its principal offices in Washington, D. C. The corporation holds a current certificate of public convenience and necessity issued by the Civil Aeronautics Board to engage in the transportation of persons, property, and mail. It also possesses a valid air carrier operating certificate issued by the FAA.

Flight Personnel

Capt. William C. Paddack, age 53, was employed by Capital Airlines on Oct. 1, 1930, and was promoted to captain June 6, 1938. He held a valid airman certifi-

cate with an airline transport rating for airplane, multi-engine land, and DC-3, DC-4, Lockheed Constellation, Vickers Viscount aircraft ratings. Capt. Paddack had accumulated 22,260 flying hours, of which 1,945 were in the Viscount. His last first-class physical examination, taken on Dec. 13, 1958, was satisfactory, with no waivers. His last semi-annual proficiency check of Nov. 23, 1958, and his last line check of Jan. 19, 1959, were satisfactory.

Copilot Michael J. Flahaven, age 27, was employed by the company on Apr. 18, 1955. He held a valid airman certificate with an airline transport rating for airplane, multi-engine land and aircraft rating for the DC-3. Mr. Flahaven was qualified as captain on DC-3 aircraft Apr. 22, 1958. He had accumulated a total of 4,073 flying hours, of which 2,033 were as copilot on the Viscount. His last first-class physical examination of Nov. 24, 1958, was satisfactory, no waivers. His last proficiency check and instrument certification was satisfactorily completed Dec. 15, 1958.

Hostess Doris E. Gulick was employed July 20, 1952. Hostess Sue Ann Wessell was employed Apr. 26, 1957.

Vickers-Armstrongs Viscount, Model 745D, N 7463, bore manufacturer's serial number 287. It was manufactured Dec. 8, 1957, and purchased by Capital Airlines Jan. 25, 1958. Since new the aircraft had accumulated 4,180 hr. The aircraft was powered by Rolls-Royce Dart engines, Model 510, which were equipped with Rotol propellers, Model (c) R130/4-20-4/12 with RA 25842 blades.

B-58A Averages 21 mi. per Minute

High altitude run on Oct. 15 of Air Force's Convair B-58A from Seattle, Wash., to Ft. Worth, Tex., covered 1,680 stat. mi. in 80 min. for an average speed of 21 mi. per minute. The aircraft was a production line plane, carried a standard pod, and was the same plane which previously had made a high-speed low-level run between Ft. Worth and Edwards AFB.

Top altitude was over 50,000 ft. and speed was maintained in excess of Mach 2 for more than one hour.

En route to Ft. Worth, the plane was refueled by an Air Force Boeing KC-135 tanker.

Visual Standards

Washington—New eye standards and eye testing procedures for civil airmen have been recommended by a Federal Aviation Agency study group. The agency is currently reviewing the recommendations to determine whether new visual standards should be established. Consultant group makes its report as part of the first comprehensive review of visual standards for airmen since 1926, and FAA Office of the Civil Air Surgeon is now studying the recommendations for the agency.

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WHO'S WHERE

(*Continued from page 23*)

Changes

John R. Long, chief test engineer, Aluminum Company of America's Cleveland, Ohio, Development Division, succeeding **Russell G. Anderson,** retired.

Roy J. Graeter, manager-electronic engineering, Special Programs Section, Defense Systems Department, General Electric Co., Philadelphia, Pa.

Robert J. Gilson, program director of the ULD-1 "Tall Tom" program, Hoffman Laboratories Division, Hoffman Electronics Corp., Los Angeles, Calif., succeeding **John F. Honey,** who has been appointed executive engineer, engineering department staff. Also: **Edgar R. Brastow,** manager, electromechanical section, engineering department of Hoffman Laboratories.

Dr. William F. Whitmore, consultant scientist on the chief scientist's staff, Lockheed Missiles and Space Division, Sunnyvale, Calif.

Andrew J. Kirchner, manager-export sales, Ex-Cell-O Corp., Detroit, Mich.

Dr. Lloyd P. Smith, director of research operations, Aeronutronic, a division of Ford Motor Co., Newport Beach, Calif. Also: **Rear Adm. Thomas G. Warfield** (USN, ret.), division marketing director.

Franklin C. Spinney, manager-research sales, Allison Division of General Motors Corp., Indianapolis, Ind.

Craig F. Timmerman, director of air traffic requirements-planning and requirements staff, General Precision Laboratory, Inc., Pleasantville, N. Y., a subsidiary of General Precision Equipment Corp. Also: **Dr. Frank A. McMahon,** manager-service and support department for GPL, and **Stanley Hayes,** assistant manager.

Daniel W. Layman, Jr., corporate director of advertising and public relations, Lear, Inc., Santa Monica, Calif.

Dr. Frank H. Shelton has joined the staff of Kaman Nuclear, Colorado Springs, Colo., a division of The Kaman Aircraft Corp.

Robert D. Hallock, manager, Inet Division, Leach Corp., Compton, Calif.

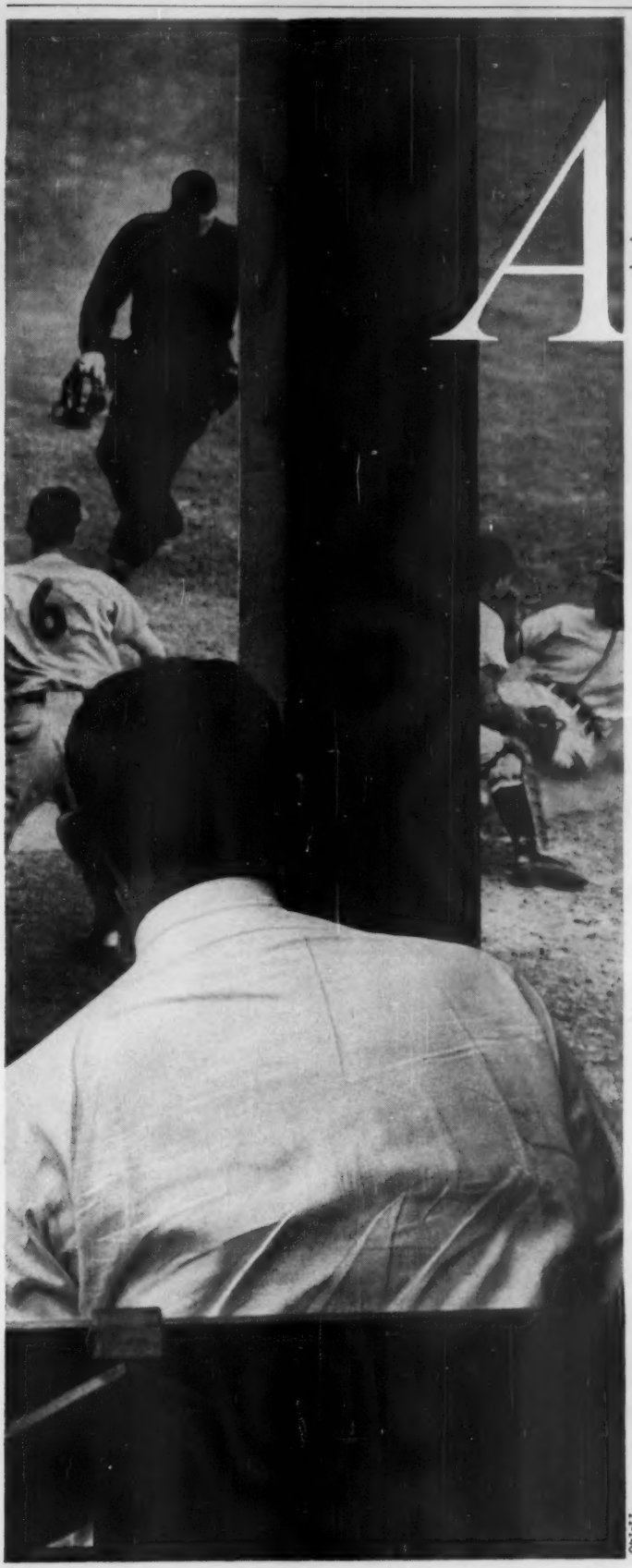
Dr. Mostafa B. Talaat has joined the Nuclear Division of The Martin Co., Baltimore, Md., to direct all research and development efforts in the field of energy conversion. Also: **Clark C. Vogel** has joined Martin's corporate staff as assistant to the general counsel.

Philip C. Wright, engineering program manager for the B-70 bomber electronics subcontract, Military Electronics Division, Motorola, Inc., Phoenix, Ariz.

Lionel Robbins, sales manager, Vernistat Division, Perkin-Elmer Corp., Norwalk.

The Arma Division of American Bosch Arma Corp., Hempstead, N. Y., has assigned **Dr. Bernard Litman** to direct the flight test program of the Atlas guidance system at Cape Canaveral, Fla.

Ross F. Miller, project manager for the GAM-87A guidance system, Nortronics Division of Northrop Corp., Hawthorne, Calif. **Frank Lynch** succeeds Mr. Miller as chief engineer, Nortronics' Electronic Systems and Equipment Department.



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Some engineers are content to stay in their own technological backyards. But many others prefer to work in an inter-disciplinary environment, where everything they do is concerned with the total system.

If you are interested in seeing and understanding the whole picture, rather than just a small segment of it, we think you'll be interested in System Development Corporation. Our work is concerned with the design and development of extremely large systems in which high-speed digital computers aid men in decision-making. The relative capabilities and roles of men, machines, and associated system components pose intriguing problems for creative minds.

At the present time we have key openings for engineers with proved analytical ability in the areas of communications, computers and associated equipment, simulation, information theory, weapons system analysis. Please send your inquiry to Mr. E. A. Shaw, SDC, 2404 Colorado Avenue, Santa Monica, California.

"A Mathematical Model of an Air Defense Operation and a Method of Evaluation," a paper by SDC's staff, is available upon request. Please address inquiries to Mr. E. A. Shaw at SDC.

SDC

SYSTEM DEVELOPMENT CORPORATION

Santa Monica, California • Lodi, New Jersey

11-140

[employment con't on page 144]

BASIC TEST FOR MEDIA SELECTION:

Ask anyone, anyone you're trying to sell in the aviation market, what publication he reads and respects most.

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A McGraw-Hill Publication 330 West 42nd St. New York 36, N. Y.

Aviation's largest engineering-management audience.

ABC PAID CIRCULATION 71,950

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The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

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Positions Wanted
Part Time Work
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Send NEW ADS to Classified Advertising Div. of AVIATION WEEK, P. O. Box 12, N. Y. 36, N. Y.

MANAGERIAL STAFF POSITION

Missile Test Systems Analysis

■ Lockheed Missiles and Space Division has an important, high-level position on the test systems analysis staff at its Sunnyvale, California facility on the San Francisco Peninsula. Advanced degree in A.E. required with strong experience in the missile/aircraft industry at the supervisory level. Excellent starting salary. Ideal living and working conditions.

For appointment regarding this position, please send resume to Mr. R. C. Birdsall, Professional Placement Staff, Lockheed Missiles and Space Division, Dept. K-17A, 962 W. El Camino Real, Sunnyvale, California. U. S. citizenship required.

Lockheed

MISSILES AND SPACE DIVISION

Sunnyvale, California

FLORIDA OPENINGS

FOR

AIRCRAFT DESIGNERS
STRESS ANALYSTS

A PROGRESSIVE RESEARCH AND DEVELOPMENT GROUP HAS OPENINGS FOR ENGINEERS EXPERIENCED IN AIRCRAFT DESIGN, AIRCRAFT SYSTEMS AND STRESS ANALYSIS. IF YOU HAVE A DEGREE IN AERONAUTICAL, CIVIL OR MECHANICAL ENGINEERING, OR ARE A GRADUATE OF A TECHNICAL SCHOOL WRITE FOR FURTHER INFORMATION AND TO ARRANGE AN INTERVIEW TO

P-2946, Aviation Week
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

Bausch & Lomb Optical Co.
Rochester, N. Y. has

OPENINGS
in an expanding field

Bausch & Lomb Optical Co. has been a leader in precision optics for many years. This leadership has been based on skills and experience of a few specialists in the "art" of optics and precision optical machinery.

The rapid moving technological world of today demands that this skill and ability be applied to many fields to support both civilian and military advances.

To accomplish this a major increase in engineering staff will be required. This increase is primarily in the Mechanical Design Department of Consumer Products, Special Products and Scientific Instruments.

Experienced Mechanical Design Engineers and Draftsmen (no optical experience required) who are interested in positions in a rapidly expanding field are invited to call or write

MR. A. L. JOHNSON
Bausch & Lomb Optical Co.
Rochester 2, New York

"Put Yourself in the Other Fellow's Place"

TO EMPLOYERS

TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

MR. EMPLOYEE you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section.

We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division

McGRAW-HILL PUBLISHING CO., INC.
330 West 42nd St., New York 36, N. Y.

ELECTRONIC
ENGINEERS—SCIENTISTS

How about YOUR future?

Beechcraft is a company where the past and the present PROVE the future is interesting and worthwhile. This is your opportunity to join an engineering team where:

LEADERSHIP in engineering design and the production of business airplanes and ground support equipment is a world-famous Beechcraft specialty.

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COMPETITIVE SUCCESS has been proved with Beechcraft's winning of the Mach 3 Alert Pod Design and Mach 2 Missile-Target awards.

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INFRA-RED
AUTO PILOT
MISSILE SYSTEMS
RELIABILITY
(Mech., Airframe or Power Plant)
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(Flutter)
AERODYNAMICISTS
AERO-THERMODYNAMICISTS
(Heat Transfer)
DESIGN
(GSE, Airframe, Power Plant and Installations or Mechanical)

For more information about a company with a long range future where your talents will build your own future — call collect or write today to D. E. BURLEIGH, Chief Administrative Engineer, or C. R. Jones, Employment Manager, Beech Aircraft Corporation, Wichita, Kansas.

All Expenses Paid for Interview Trip

Beechcraft

Wichita, Kansas Boulder, Colorado

Openings for

DESIGN ENGINEERS

for

GAS TURBINE ENGINES

in Solar's rapidly expanding gas turbine programs in sunny San Diego

Solar has immediate openings for Preliminary Design and Product Design Engineers in its fast-moving gas turbine programs. Several new contracts have been received for industrial, non-military applications, as well as certain new military turbine development jobs. This growing diversification has created expanding challenges and opportunities. Solar is a world leader in small gas turbines, having pioneered in their design and development since 1945. The company has built and sold more than 2500 gas turbines. Join in this exciting work now for a brilliant future.

QUALIFICATIONS

B.S. in Engineering preferred, plus at least three years experience in gas turbine design. U.S. citizenship not required for some of the positions open.

SOLAR SPECIFICS

Solar is a medium-sized company (2500 people) that has been in the mechanical and aeronautical engineering fields since 1927. It is big enough to offer the most advanced personnel policies, yet small enough so you don't get lost in the crowd. Salary and performance reviewed semi-annually. Liberal relocation allowances. The special professional status of engineers is appreciated and recognized. A new 60,000 sq. ft. engineering building, necessitated by expanding research and development, will be completed soon on the edge of San Diego Bay.

SEND RESUME

Please send resume of your qualifications to Louis Klein, Dept. E-443, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY

LIVE BETTER, TOO! In addition to greater opportunities for personal achievement, Solar offers you the chance to live better in sunny San Diego. This famous resort area has the finest year-around climate in America. Cultural, recreational and educational facilities are excellent. You and your family will enjoy life more at Solar in San Diego.

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Achievement is habit at Avco! A leader in the field of atmospheric re-entry, Avco is now providing significant contributions to basic and applied research in Space and Missile Technology.

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- **PHYSICS AND CHEMISTRY**
- **COMMUNICATIONS**
- **MATERIALS**
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Attractive working environment outside of metropolitan Boston. The large, fully equipped, modern laboratory is close to Boston educational institutions and cultural events. The division offers a liberal educational assistance program for advanced study.

Forward your inquiry to:
Mr. Richard Rubino
Manager, Personnel Relations
Dept. AW-11

Avco
Research & Advanced Development
201 Lowell St., Wilmington, Mass.

new openings in Florida with Vitro

Vitro Laboratories' Florida operation, Vitro Weapons Services, is rapidly expanding its technical staff to operate the nation's newest missile test range, the EGLIN GULF TEST RANGE.

High level supervisory and staff opportunities exist at five Florida locations: 1. Fort Walton Beach; 2. Port St. Joe; 3. Tarpon Springs; 4. Naples and 5. Key West.

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RADAR TECHNICIANS – with training and experience in one or more of the following radar systems: MSQ-1, MSQ-1A, FPS-16, Nike, M-33, MPS-9, SCR-584, CPS-6, FPS-3 and FPS-20.

ELECTRONIC TECHNICIANS – with a solid background in electronics and several years experience in Telemetry, Data Converters, Oscillograph Recorders or Range Electronic Instrumentation.

For your opportunity to relocate in Florida with an electronics industry leader, address a confidential resume to D. D. Cox, Personnel Director, Vitro Weapons Services, 119 East Main Street, Fort Walton Beach, Florida, Dept. AW.

Vitro
LABORATORIES
DIVISION OF VITRO CORPORATION OF AMERICA
Other laboratories at West Orange, N. J., and Silver Spring, Md.

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Design Engineer—M. E. Degree. Minimum 5 years experience in design, preparation of plans, specifications, and estimates for construction and modification of mechanical building equipment (air conditioning and heating), utilities and piping systems. Send complete resume and salary requirements to Technical Employment, ARO, Inc., Arnold Air Force Station, Tennessee.

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Helicopter pilot desires permanent change. 4,000 helicopter hours, college degree, age 35, desire flying position, foreign or domestic. PW-3044, Aviation Week.

23 years experience—overhaul, maintenance, modifications, inspection and supervision. A&E licensed. PW-3119, Aviation Week.

Experimental Test Pilot seeks position involving development and test flying and engineering. Age 29, 2450 hours, SMEL, instrument, jet qualified, M.S. Aeronautical Engineering, M.I.T. Resume on request. PW-3114, Aviation Week.

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BUSINESS OPPORTUNITY

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Competent men for your staff? . . . employment? . . . or are you looking for—or offering—a business opportunity of special interest to readers of this publication? You can get their attention—at small cost—through an advertisement in the Employment Section of AVIATION WEEK.

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in Solar's rapidly expanding space-age programs

QUALIFICATIONS:

This is an excellent position for a man with strong creative ability. He should have an advanced degree and about 10 years of successful experience in the design of missiles, related equipment, or major components and subsystems. From stated operational requirements, he should be able to evolve optimum configuration and performance details. These must integrate aerodynamic, structural, avionic and manufacturing requirements. Though he will be supported by specialized departments in these fields, he should be able to do preliminary analyses and to advise the specialists in their more detailed work. As a supervisor he will direct a small group of preliminary design specialists.

SOLAR SPECIFICS

Solar's space-age R&D programs are expanding rapidly. Exciting current projects include an ARPA anti-missile defense system. Solar is a medium-size company (2500 people) with a successful history since 1937. A new 60,000 sq. ft. engineering building will be completed this year. In addition to greater career opportunities, Solar offers you the advantage of living in sunny San Diego, California—with the best year-round climate in America and excellent cultural, educational and recreational facilities.

SEND RESUME. Please send resume of your qualifications at the earliest opportunity to Louis Klein, Dept. E-448, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

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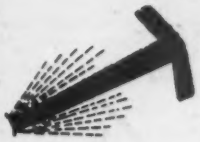
AIRCRAFT COMPANY

"Transistorized" Engineers



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INSTRUMENT DEPARTMENT

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SEARCHLIGHT SECTION

(Classified Advertising)

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EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE:
$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
PROPOSALS, $1.80 a line an insertion.
BOX NUMBERS count as one line additional in undisplayed ads.

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D18S—New interior, painted, hydromatics, dual A.R.C. omni, ILS, LVTR36 VHF, ADF, boots, anti-icing, etc. New ship guarantee, **$29,500.** See at Pompano.

D18S—Excellent interior, painted exterior, dual instruments, eyebrows, hydromatics, deicers, oleo drag legs, omni, VHF, ADF, ILS, LF, dual omni, etc. Special **$23,500.** See at St. Louis.

Convair 340 & Martin 4-0-4—Available. Also engineering for autopilot, radar, radome.

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DC3—24 seat airliner, Collins 51R omni, ILS, ADF, ARC-1 50 ch VHF, LF, Sapphire 360 ch VHF, etc. **$39,-500.** With 17 seat executive interior, dual Collins 51R omni, ILS, ADF, Sapphire 360 ch VHF, ARC-1 50 ch, etc. **$59,500.** See at St. Louis or Pompano.

Two Convair 240s—NTSO engines and props. Engine analyzer. Excellent condition. World's best price. Available for immediate inspection. See at Pompano.

Aero Commander 680—Late model, like new. 7 place, full executive Collins and A.R.C. radio. Traded on Super-92 DC3. Special wholesale price, **$59,500.** Sale or lease. See at Pompano.

Custom 18 Twin Beeches—Two now in work. 1951, NTSO low time airframes, engines, hydromatics, Collins omni, A.R.C. omni. A.R.C. 210 VHF, airstair, deluxe Custom 18 interiors with picture windows, new ship guarantee, **$49,500.** See at Toledo and Trenton.

Grumman Goose—Amphibian. Hartzell props, deluxe executive interior, metal wings. See at Pompano.

Super-92 DC3—Deluxe executive interior, lightweight landing gear doors, Collins and Bendix radio. Freshly reconstructed, new ship guarantee. Sale or lease.

C47A—Dual Collins 51R omni, ILS, A.R.C. 210 VHF, standby VHF, HF, ADF, etc. All new control surfaces, cargo door with passenger door inside, raised floor, insulated cabin, 4 folding chairs. New ship guarantee. **$79,800.** See at Pompano.

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Or possibly pressurized Twin Engine Aircraft

Send full details, specifications and performance
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Aviation Week, P.O. Box 12, N.Y. 36, N.Y.

FOR SALE

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Aero Comm. 680. TTA 906; R.E. 704; L.E. 4 hours. Dual omnis, ADFs, VHF comm. and flight instruments. L-2 auto pilot, new paint. $69,500. E. J. Fleming, 8 Walnut Road, Whippany, N. J. TU 7-5932.

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If there is anything you want
that other readers can supply
OR . . . something you don't want—
that other readers can use—
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ADVERTISERS IN THIS ISSUE

AVIATION WEEK, NOVEMBER 23, 1959

AERONCA MANUFACTURING CORP. 134
AEROQUIP CORP. 104
AIR REDUCTION SALES CO., DIVISION OF AIR REDUCTION 64
AIRWORK CORP. 44
AMERICAN BOSCH ARMA CORP. 66
AMPHENOL-BORG ELECTRONICS CORP. 132

BARRY CONTROLS, INC. 15
BELL HELICOPTER CORP. 10
BENDIX RADIO DIVISION, BENDIX-AVIATION CORP. 20
BLISS CO., E. W. 67
BOEING AIRPLANE CO. 126
BRUNSWICK-BALKE-COLLENDER CO. 11

CALIF. TECHNICAL INDUSTRIES 133
CANADAIR, LIMITED 48-49
CANNON ELECTRIC CO. 136
CONNECTICUT HARD RUBBER CO. 40
CRUCIBLE STEEL CO. 62-63

DEUTSCH CO. THE 127
DIT-MCO, Inc. 73
DORNE & MARGOLIN, INC. 97
DOUGLAS AIRCRAFT CO. 90-91

ECLIPSE PIONEER DIV., COMPONENTS 100-101

THOM. A. EDISON, INSTRUMENTS DIV. McGRAW-EDISON 22
ELECTRONIC COMMUNICATIONS, INC. 75
EMHART MFG. CO., MAXIM DIV. 72
ESSO EXPORT CORP., AVIATION PDTS. 12
ESSO STANDARD OIL CO. 124
EX-CELL-O CORP., AIRC. DIV. 4

FAIRCHILD CONTROLS CORP. 5
FUTURECRAFT DISTRIBUTION CORP. 125

GARRETT CORP. 14, 96, 138, 149
GENERAL ELECTRIC CO. 111, 114-115
GIANNINI CONTROLS CORP. 106
GOODYEAR TIRE & RUBBER CO. 3

HARRISON RADIATOR DIV., G.M.C. 7
HAWKER SIDDELEY AVIATION 122
HILLER AIRCRAFT CORP. 86
HOLLEY CARBURETOR CO. 108-109

INTERNATIONAL NICKEL CO., INC. 8

JOHNS-MANVILLE CORP. 88

KAMAN AIRCRAFT CORP. 78
KOPPERS CO., INC. 51

LINDE CO., DIV. UNION CARBIDE CORP. 24
LISLE CORP. 6
LITTON INDUSTRIES 138

MARQUARDT AIRCRAFT CORP. 76-77
MD BLOWERS, INC. 99
METALS & CONTROLS CORP. 59
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY 94-95
MOOG SERVOCONTROLS, INC. 13
MOTOROLA, INC., MILITARY ELECTRONICS DIV. 53-55, 139
MURRAY CO., INC., A. B. 82

NATIONAL UTILITIES CORP. 125
NORTHROP CORPORATION 130

PACIFIC SCIENTIFIC CO. 65
PESCO PDTS. DIV., BORG WARNER CORP. 58

RADIATION, INC. 96
RADIO CORP. OF AMERICA ..... 3rd Cover, 135
RAYTHEON CO., MISSILE SYSTEM DIV. 140
RED BANK DIV., BENDIX AVIA. CORP. 82
REPUBLIC STEEL CORP. 70-71
RYAN AERONAUTICAL CO. 18

SAFEWAY HEAT ELEMENTS, INC. 58
SCINTILLA DIV., BENDIX AVIA. CORP. 100
SERVOMECHANISMS, INC. ..... 4th Cover
SINCLAIR REFINING CO. 42
SOLAR AIRCRAFT CO. 102
SPACE TECHNOLOGY LABS. 60
STANDARD STEEL CORP. 17
SUNDSTRAND AVIATION DIV., OF SUNSTRAND CORP. 9
SYLVANIA ELECTRIC PRODUCTS 16

TASK CORPORATION 83
TELECOMPUTING CORPORATION 118
THIOKOL CHEMICAL CORP., ROCKET DIV. 128-129

U. S. STEEL CORP. 120-121

VOI SHAN MFG. CO. ..... 2nd Cover

WESTINGHOUSE ELEC. CORP. 84-85

YUBA CONSOLIDATED INDUSTRIES, INC. 61

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 141, 144-147

EQUIPMENT
(Used or Surplus New)
For Sale 147-148

WANTED
Miscellaneous 148

ADVERTISERS INDEX

Avco 146
Bausch & Lomb Optical Co. 144
Beech Aircraft Corp. 145
Chemstrand Corp., The 147
East Coast Aviation Corp. 147
Engine Works 148
General Electric Co., Instrument Dept. 147
Lockheed Missiles and Space Div. 144
Lund Aviation (Canada) Ltd. 147
Rommert-Werner Inc. 147-148
Solar Aircraft Co. 143, 147
Southern Flight Service Inc. 148
System Development Corp. 141
Vitro Weapons Systems 146
Weld Assoc., Wm. C. 148

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Send resume to: Mr. T. E. Watson

THE GARRETT CORPORATION

AiResearch Manufacturing Division

9851 So. Sepulveda Blvd., Los Angeles 45, California

LETTERS

Vertol 107 Engines

The first five production models of Vertol's Model 107 multi-turbine helicopter optioned by New York Airways will be powered by General Electric CT58 turboshaft engines, not Lycoming T53 turbines as indicated in the Nov. 9 AVIATION WEEK, p. 47.

Also selected to power the five Sikorsky S-61 helicopters recently purchased by Los Angeles Airways, the CT58 is the first and to date the only U. S. gas turbine certified by the FAA for commercial helicopter service.

RALPH HEUMAN
Manager, Product Information
General Electric Co.
Small Aircraft Engine Department
Lynn, Mass.

Race for Space

Mr. Claflin has done us a service by pointing up the "confusion and disagreement as to exactly what we are trying to accomplish" in space (AW Nov. 2, p. 134). Perhaps it would be useful to discuss this in "Letters."

I, for one, believe the "race for space" is a valid one. With due deference to the IAS, I feel quite capable of replying to Mr. Claflin inasmuch as his comments on space probes falling into the sun indicate at least some ignorance about the conditions under which the "race" is being run.

The goals, as I see it, have always been visible—the planets and asteroids which compose our solar system—perhaps that is why Mr. Claflin finds them too obvious. The starting time is hard to define but certainly was in the last century in terms of accomplishments, and no runner really got going until World War II. The other conditions have been set by history and nature—the advances in basic technology, the competition in missiles armed with nuclear warheads, and the physical laws which govern our existence.

The basic "ground rule" is not mere "national physical safety here on earth" but, if it can be summed up in a phrase at all, national immortality. By this I mean our children's children's well-being as well as our own and their ability to live as they choose and govern themselves as they choose —including their adoption of a supranational government, if they so wish. I would also wish that they could look back upon their national history with pride. "Immortality," realistically, also implies growth and continued national stature.

Exploitation of the resources of our solar system—including possible colonization—is now within the realm of possibility. Not all the advances toward this will, or need be, spectacular—I agree with Mr. Claflin—but, unless we are willing to accept as a premise that the Russians will certainly give up their rights to the new frontiers which they are reaching first and make the benefits of their progress freely available to all—and I do not—then it follows that we must be in a position to exercise claims through physical possession first. Whether we then open these frontiers to others, including Russians, is another matter, but I have more faith in my own government than Russia's.

There will be other and undeniably important advantages from leading the race as well—full scientific information; advances in medicine, astronomy and technology such as have already occurred; improved and superior weapon systems and components; propaganda; undreamt of discoveries in all fields (look at what the Americas meant to Europe, for a crude example). The race for space is really a struggle for continued national existence.

J. KENDRICK NOBLE, JR.
Noble and Noble Publishers, Inc.
New York, N. Y.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Pilot Retirement

Robert Cook's story (AW Oct. 5, p. 36) about industry opinion of FAA's proposed rule to retire pilots at an age decreed by FAA was as complete and unbiased coverage on the subject as a reader would want.

In your Oct. 26 issue (p. 154), Mr. Alan T. English makes some additional observations on pilot retirement. I surmise he wrote his letter before Mr. Cook's story appeared, but his letter prompts this comment.

I agree with one of Mr. English's thoughts that 60 cannot be a magical cutoff age. However, somewhere along 60 to 65 pilots should be willing to retire. It would depend upon individual pilot fitness and company policy (negotiated?), but it should not be by arbitrary government decree.

There are statistics and statistics.

Mr. English points out that data on 27 aviation accidents involving younger pilots is not applicable to older pilots. Similarly, I would think that the "abundance of evidence" of the run of the mill statistics should not apply to pilots as a group.

Aside from their prima donna attributes I have to admit that most airline pilots were originally screened for high physical standards. Furthermore they have been medically screened and performance checked two to five times a year ever since, depending upon their affiliations and activities.

Such screening accomplishes much in the way of concrete evidence.

Actuarial data on roughly comparable select groups appears as favorable to the age group 50 to 65 as to the group 40 to 49, as I interpret the data. A relatively simple medical screening reduces the mortality experience among those selected to around 25% to 35% of the normal expected mortality within two years following the selection.

The table of distribution of deaths by causes shows that the percentage of deaths from heart or circulatory diseases (FAA's worry) varies only approximately 1% between the age 40 to 49 group and the age 50 to 65 group.

There seems to be considerable medical evidence that a heart incident is not so apt to be fatal to a younger man. Therefore, I would conclude from the foregoing mortality data that there are probably as many, if not more, heart incidents in the 40 to 49 select age group as in the 50 to 65 select age group. While there would not be as many fatal heart incidents in the younger group the incidents would be just as suddenly incapacitating as far as an airplane driver might be concerned.

Now does the FAA propose to fire or retire all airline pilots over 40?

This business of the government deciding by age when one cannot steer could get a bit involved. Bus drivers would be next. Their passengers are more continually exposed. Buses are not equipped with dual controls and drivers; they will run off the road or into something quickly if not guided correctly.

But why confine this government thinking to pilots or even bus drivers? Why not include some other drivers over 40 or any other age out of a hat? In fact, I would think it poetic justice if someone could persuade FAA to propose a rule that all its medical examiners turn in their drivers' licenses unless they can absolutely prove that they are not a hazard to the community in any auto not equipped with dual controls.

Could be that the pilots wouldn't be worried about losing their licenses any more.

ROBERT E. TRIMBLE
Washington, D. C.

Jet Turbulence

Reference is made to the Nov. 9 edition of AVIATION WEEK, p. 133, subject "Piper Crash Blamed on C-124 Turbulence."

It was good to see the CAB accident investigation report together with the "Safety Message for Pilots."

This past Oct. 4 I was flying a Piper Tri-Pacer out of Zahn's Airport with two passengers on a perfectly clear day. While at 2,500 ft. heading toward the south shore of Long Island, I pointed out a Boeing 707 which was crossing our path and which was sufficiently far ahead to have the silhouette discernible as a 707. I would judge that it was between one and two miles ahead of us. When I crossed what had been its path, after the aircraft had completely disappeared, I had thought that no turbulence could possibly exist. We were subject to an extremely sharp and sudden bump that rattled our teeth, and if it had not been for the fact that we all wore safety belts, an injury could have occurred.

May I add my warning to stay very clear of the paths left by large aircraft despite the fact that such aircraft may have disappeared in the distance.

HOWARD S. STERNE
Sterne, Carr & Farr Co.
New York, N. Y.

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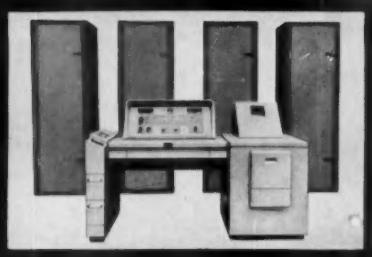

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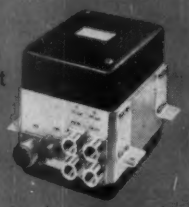

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